POWER PLANT ENGINEERING

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Stopped by the Armistice

AT EDGEWOOD ARSENAL AN EXTENSIVE INDUSTRY FOR THE MANUFACTURE OF CHEMICALS FOR WAR WAS DEVELOPED AND PUT INTO OPERATION IN ABOUT ONE YEAR. STEAM AND POWER IMPORTANT FEATURES INVOLVING THREE PLANTS

ON THE morning of April 23, 1915, big scare heads in the newspapers announced "Huns Gas Allies," or "Allied Trenches Stormed by Poison Gas," or "Allied Armies Wiped Out by Deadly Gases." We read the accounts of these attacks and the terrible sufferings of the unfortunate armies with surprise and horror, and the surprise to us was no more than to the allied governments which were totally unprepared for gas warfare as it was launched on that spring day by the Huns.

This was the beginning of gas warfare, nearly 2 yr. before the United States entered the struggle. From that date to the signing of the armistice the use of toxic gases and other chemicals increased continuously and the manufacture of these chemicals on a commercial basis was one of the big problems faced by the United States.

Every possible aid to the solution of this problem was given by the Allies, but new gases were being used every day, each requiring different equipment for manufacture upon any adequate scale, so the need for research, inves-

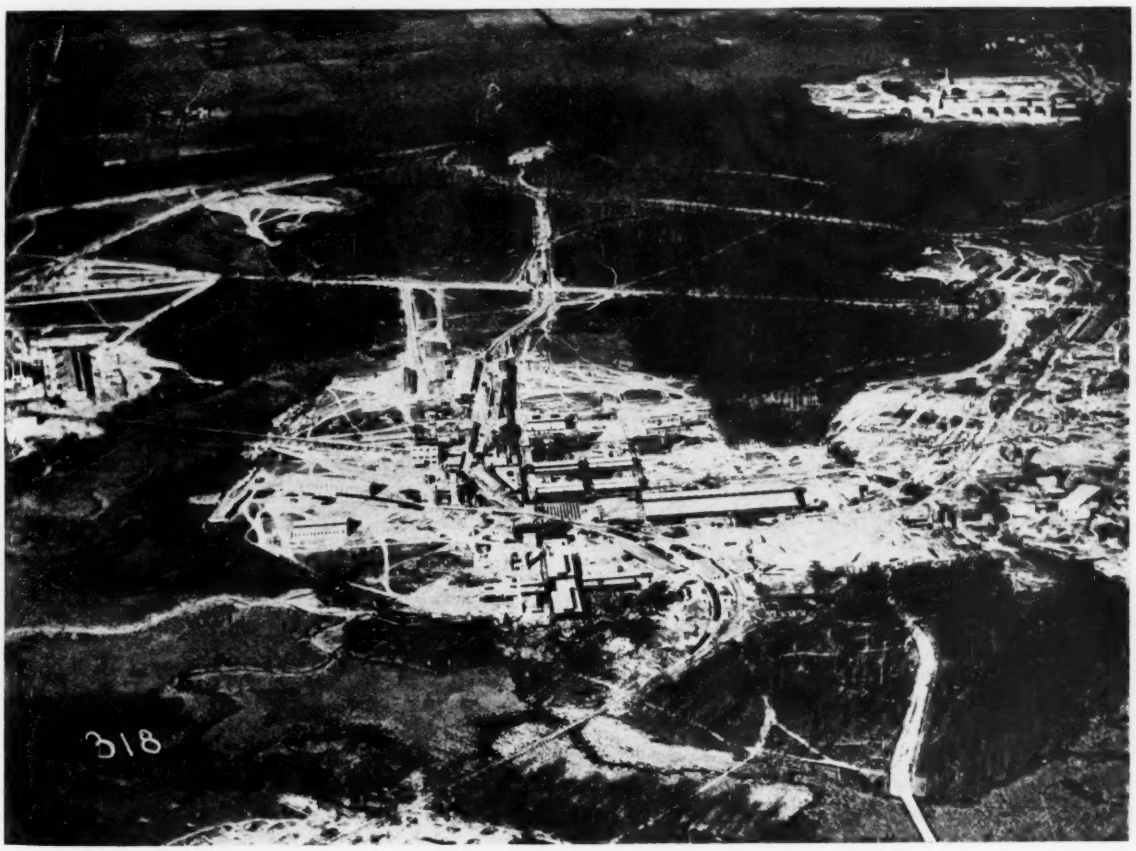


FIG. 1. EDGEWOOD ARSENAL AS SEEN FROM AN AIRPLANE DEC. 4, 1918. FROM LEFT TO RIGHT: CHLORINE PLANT CHEMICAL PLANTS AND FILLING PLANTS

tigation and engineering became apparent at the outset. Due to its success in dealing with mine gases, the Bureau of Mines voluntarily undertook the task of research and these four problems came up for solution: Gas masks, gas shells, toxic gases, and shell filling machinery.

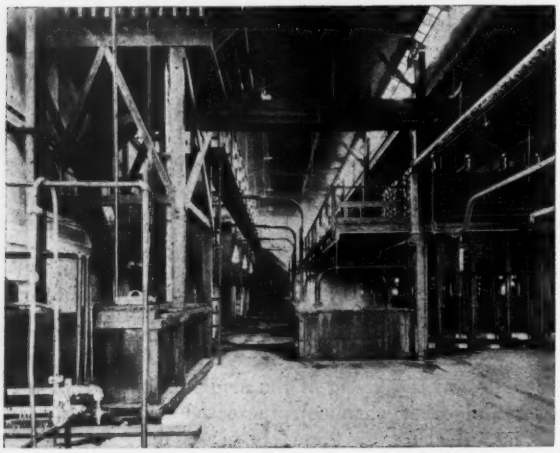


FIG. 2. INTERIOR VIEW OF PHOSGENE MIXER BUILDING SHOWING CATALIZER BOXES FILLED WITH CARBON AND CONDENSER COILS

The Edgewood Arsenal was selected as the most desirable location for the manufacture and loading of the gases by the government. It is on an arm of Chesapeake Bay with harbor facilities, twenty odd miles from Baltimore, Md., and accessible on the main line of the Pennsylvania R. R. between Washington and Philadelphia.

FIG. 3. FILLING 75 MM. SHELLS WITH MUSTARD GAS. THESE MEN ARE PLACING AND REMOVING SHELLS FROM THE RACKS; THE ACTUAL FILLING IS DONE AUTOMATICALLY IN THE TUNNEL SHOWN IN THE BACKGROUND

To this arsenal were given these two general problems:

(a) The procurement of the necessary toxic gas supplies, either by direct purchase from existing chemical firms or by the building and operating of government plants, and

(b) Loading of this material into shells.

After due consideration, the decision was made to build a government plant, which was authorized in June 1917.

From an industrial standpoint the problems of the filling plant were, in a general way: The loading of shells with toxic gas, in liquid form, as far as possible by machinery. This must be done in a well ventilated room or tunnel by machinery operated from outside the tunnel to insure safety to the workers. The shells were closed by standard tapered pipe thread, the plugs being operated by automatic machinery. (This was done so effectively that no leaks were reported.) Conveying machinery of a special nature was necessary for conducting the shells through the filling tunnel. Refrigerating machinery was also essential to keep gases in liquid form, as their boiling temperature is below that of normal atmosphere. Two filling plants were installed and these were served by one refrigerating plant.

FIG. 4. EXTERIOR VIEW OF PRINCIPAL POWER PLANT

Co-operating with the government in developing and installing the machinery in this plant were companies most of whom are known to readers of Power Plant Engineering: Waterbury-Ferrell Foundry & Machine Co., Reynolds Machine Co., Liquid Carbonic Co., Karl Kieffer Machine Co., Spray Engineering Co., Triumph Ice Machine Co., Link-Belt Co.

The two gases which had proved most effective up to the time of the development of this plant were phosgene and chlorpicrin, and these had been adopted as standard by the allied nations. No commercial means existed in this country for the manufacture on anything like an adequate scale so this became the immediate problem.

Phosgene had been used in the manufacture of dies for a great many years in Germany, but had never been developed here, although, of course, it was no secret in laboratories, and since the beginning of the war had been made to a limited extent by the Oldbury Electrochemical Co., of Niagara Falls, which company co-operated with the Government in developing means for its manufacture on a large scale. Phosgene is made by passing carbon monoxide gas and chlorine gas over carbon

under proper heat conditions, resulting in the following chemical reaction: $C\,O + 2\,Cl = C\,O\,Cl_2$.

The manufacture of chlorpicrin in laboratories was also well known and was made by several companies in this country on a semi-commercial scale, but not in sufficient quantities to meet the demands of the government. This gas is made by passing live steam through a mixture of picric acid and bleaching powder (the so-called chloride of lime) under well regulated conditions, thence into a still in which it is condensed.

The first development was a filling plant on which construction work began October 15, 1917. Then due to the uncertainty of supply from outside firms, construction on the manufacturing plants was begun on January 25, 1918. Among the products of the plant at the time the armistice was signed were phosgene, chlorpicrin, mustard gas, chlorine and bromine.

Power Requirements

To serve this entire plant, two power houses were in operation and one other in the course of construction at the time the armistice was signed. What is known as No. 1 contains ten 400-hp. water tube boilers, which furnish steam to drive two 2000-kw. and two 500-kw. turbo generators, also an ice machine direct connected to a Corliss engine.

The second plant was used principally for evaporation purposes, being equipped with eight 500-hp. vertical water-tube boilers, which carried steam pressure of 175 lb. Two 750-kw. turbo generators acted as reducing valves for the steam pressure lowering it to 20 lb. at which it was used in the processes.

The third plant, which was designed along common central station lines, is the largest of all, is only partially completed and will probably never be put into operation.

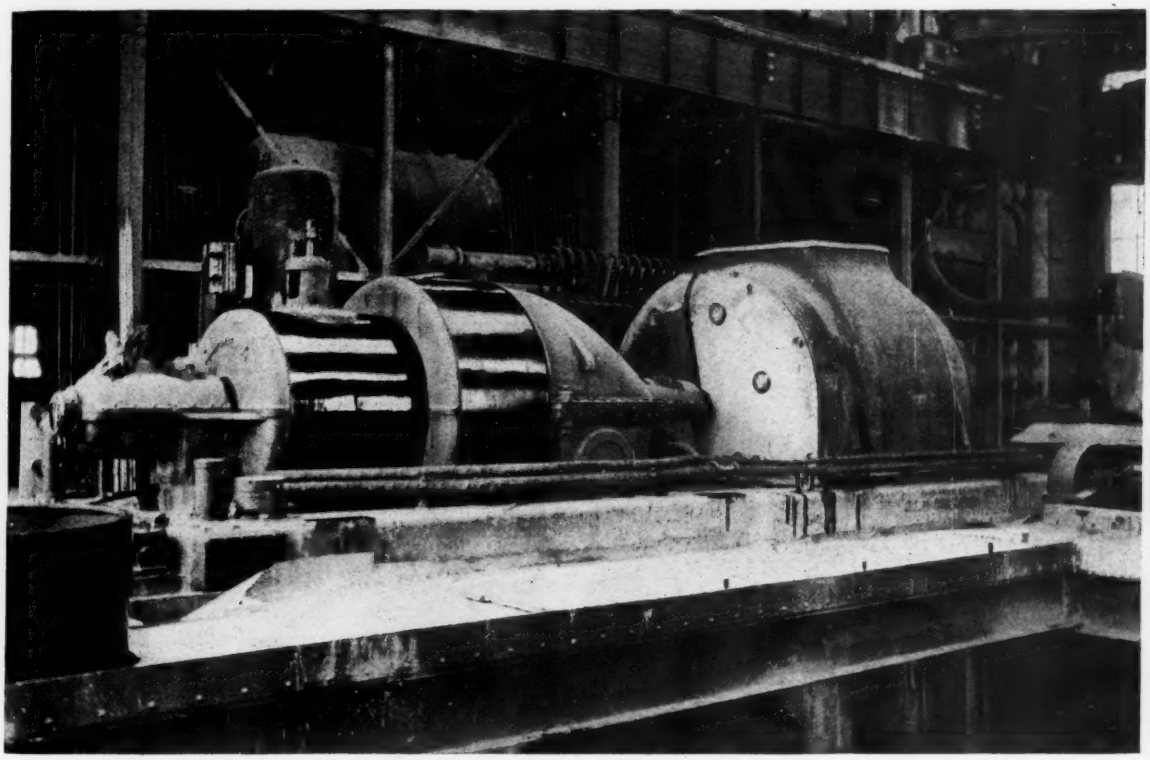


FIG. 6. ONE OF THE TURBINES NEARLY READY FOR OPERATION

For the readers of Power Plant Engineering, the details of processes for manufacturing these chemicals and their effects upon the human body are of only passing interest, but from what has been said it will be realized that a great amount of power was required, for the processes require heat, refrigeration, ventilation, electrolytic action, light and power for running all kinds of machinery.

To meet the initial requirements for power a 10 mi. transmission line was put up connecting the plant to the lines of the Pennsylvania Water & Power Co., and the Consolidated Gas Electric Light & Power Co. This provision enabled the plant to get on a working basis while its own power plants were being built.

It will interest power plant men to know that this plant was being built to perform its work in an economical way with reasonable assurances against shutdowns, and with as few men as modern practice will permit. An outline of the plant as it was proposed, with a few views showing how far the work had progressed will be given.

Considerable space for the storage of coal was provided outside the building. To this yard, the coal would come on railway cars being unloaded either by gravity, when drop bottom cars are employed, or by means of a locomotive crane and grab bucket. The railroad track

extends into the building and would permit dumping coal to a crusher, to bunker or to scraper conveyor that delivers coal from bunker to a skip hoist. Over the aisle between the rows of boilers is a series of bunkers, which receive coal from a scraper conveyor fed by the skip hoist. Automatic scales are provided for weighing the coal on its way to each stoker hopper.

The plans called for 10 boilers, set in two rows with the firing aisle between. The boilers are of the vertical water tube type served by gravity underfeed stokers each having seven retorts. For operating the stokers, two vertical steam engines are provided for each row of five boilers as will be noted in Fig. 5.

Provision was made for forced draft under the fuel bed, the gases to be carried through breechings for each row of boilers direct to a self supported steel stack, no economizers being planned for.

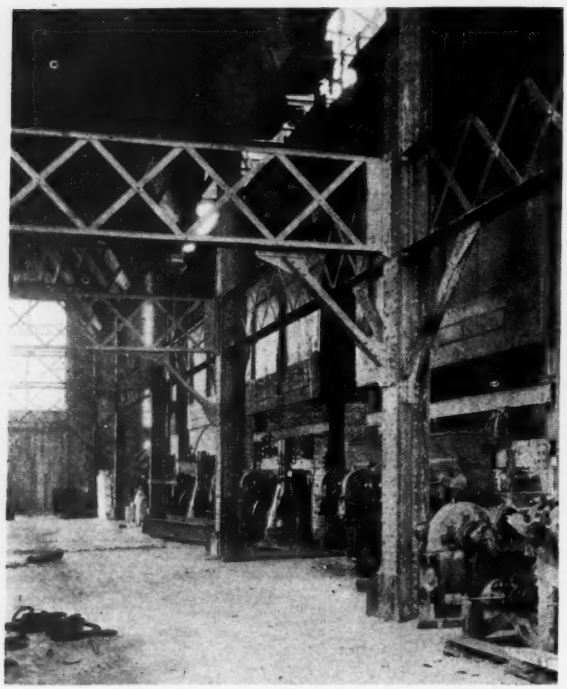


FIG. 5. CONDITION OF BOILER ROOM AT PRESENT TIME

Two feed water heaters were installed; these are of the open type arranged to take exhaust steam from the auxiliary units, the make-up water coming from the service supply as the bay water is slightly salt.

Plans called for two steam turbo generators, each of 10,000-kw. capacity, developing three-phase alternating current of 25 cycles at 6600 v. and run at a speed of 1500 r.p.m. Directly beneath the turbines provision was made for surface condensers which would be supplied with condensing water from the bay through two large cast iron pipes, the intake to which is through a traveling screen of three sections. The two circulating pumps are located in the rack house, each being of the 30-in. centrifugal type, driven by a 300-hp. motor at 360 r.p.m.

At the extreme right of the building, shown in Fig. 4 is the compartment provided for switches and transformers. Line voltage would be the same as that of the generators, 6600, so that no step-up transformers were planned for, but the voltage of motors about the plant is 440 and step-down transformers are provided.

The output of this plant was to be used principally in the chlorine plant, much of it for electrolytic processes being changed from alternating to direct current by rotary converters.

All work on this plant was stopped not by the mighty guns of the enemy nor his armed hosts, but by his cry of "enough," as evidenced by a "scrap of paper," the armistice.

Here we have it, a modern power plant almost ready to run, built in a remarkably short space of time. It

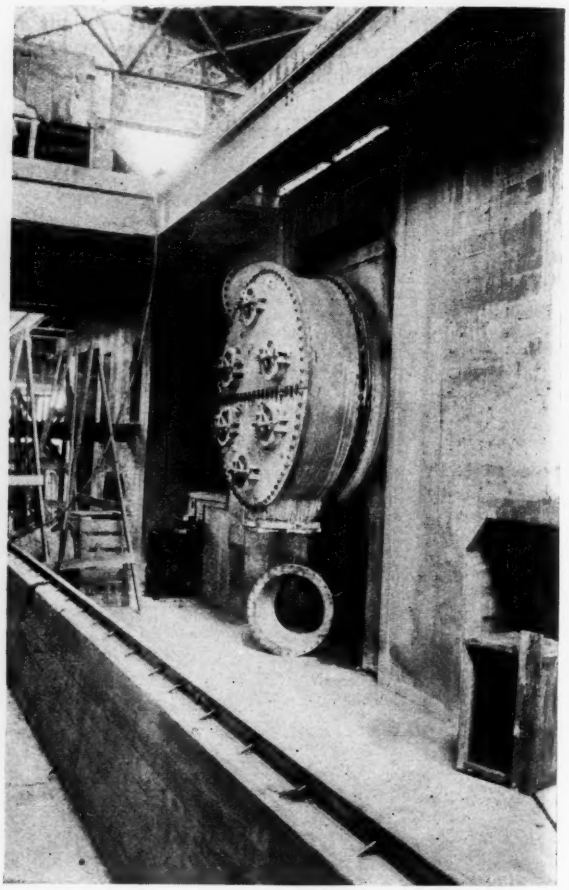


FIG. 7. SURFACE CONDENSER INSTALLED UNDER TURBINE

would be the pride of any fair-sized city in the country. The machinery was built under rigid government specifications and has never turned over in actual use. Its location apparently forbids its use for peaceful industries. Disposition of the machinery seems, at present, the only practical course for the government to follow which will probably be done when peace has become definite and not subject to if's, but's and provided's.

"EXTRAVAGANCE rots character; train youth away from it. On the other hand, the habit of saving money, while it stiffens the will, also brightens the energies. If you would be sure that you are beginning right, begin to save."—THEODORE ROOSEVELT.

Economizer Practice

SAVING, MATERIALS, CLEANING, KEEPING TRACK OF PERFORMANCE, TEMPERATURES, GAS VOLUME, AIR LEAKAGE. BY M. E. ALONE

AT PRESENT the tendency in steam boiler plants is to operate the boilers, particularly those boilers equipped with forced draft, at a high rating. The advantages of this method of operation are many, but one great disadvantage is the high stack gas temperature, for the greater the load carried on any one boiler, the higher the waste gas temperature. In order to overcome the waste of heat to the stack, economizers have been installed, generally in a bypass flue, between the boiler and the stack. Excellent results have been obtained from economizers, the saving in fuel consumption often being as high as 25 per cent. Of course, the higher the inlet gas temperature to the economizers, the greater is the saving in fuel.

In the steam boiler the lowest limit to which the stack temperature may be reduced is necessarily the steam temperature; while in the economizer the lowest limit is that of the feed water. In average boiler operation it is usual to have about 85 per cent reduction of the available temperature drop of the gas; that is 85 per cent drop in the temperature between initial and possible outlet gas temperature, the latter, of course, being equal to the steam temperature. In order to obtain 95 per cent reduction, the boiler heating surface would have to be increased by 60 per cent. In many plants it is doubtful if the gain due to lower stack temperature would warrant the necessary expenditure for the additional boiler heating surface. Heating surface, in the form of an economizer, equivalent to 60 per cent of the boiler heating surface would have many advantages over the addition of 60 per cent heating surface to the boiler. One great advantage is the fact mentioned above that the lowest limit to which the waste gas may be cooled is that of the feed water.

Cast iron is ordinarily used in economizer construction, although wrought iron and steel have sometimes been used. There is less danger of corrosion with cast iron than with steel, although good results have been obtained with the latter. Corrosion is usually caused by leaky joints or too cool feed water to the economizer. Generally little trouble is found with feed water around 120 deg. F. The dew point of the waste gas determines the feed water temperature for if the water is below the dew point, the vapor in the gas will condense out in the form of sweat on the economizer tubes. Moisture mixed with soot forms a spongy coating on the outside of the tubes which tends to collect the acids formed by the combustion of the fuel, and these attack the tubes, causing corrosion and pitting.

The outside surface of the tubes should be smooth when first installed. It is claimed that soot will not stick to the tubes if they are hot and smooth. Any small irregularity on the surface of the tubes will tend to fill with soot, which always has a detrimental effect on the operation of the economizer.

CLEANING TUBES

WHEN economizers were first used, no provision was made for cleaning the outside of the tubes. It was necessary to bypass the economizer periodically and wash the outside of the tube. This method was unsatisfactory, so scrapers were developed to clean the elements. Each tube is encircled with a set of scrapers which travel continuously up and down the tubes at a slow rate of speed, removing the soot by this operation. The operating mechanism for the scrapers is usually placed above the economizer and motive power may be supplied by motor or steam engine. A space is generally provided below the bottom header into which the soot may drop to be removed later, either by conveyors or by hand. Much better economy was obtained by this method of tube cleaning than by the intermittent system, as the tubes were practically clean all the time. Due to the heat and to the location of the mechanism, however, oftentimes difficulty is experienced in keeping the mechanism in proper working condition.

Another method of cleaning the external tube surface is by means of a permanent installation of steam soot blowers, steam nozzles being so arranged that the entire surface of the economizer tubes can be thoroughly cleaned. Due to the comparatively low temperatures in the economizer there is little difficulty met with the use of steam blowers as compared with their use on steam boilers and they require little attention after being installed. In some plants compressed air is used in place of steam.

Soot is an excellent insulator; 1/16 in. of soot on a tube would have the same effect on heat transfer as if the tube were tightly wrapped with ⅛ in. of asbestos paper. On account of the low temperature difference between the water and waste gas in the economizer, it will readily be seen how important it is that the tubes be kept clean.

Inside the economizer tubes are subjected to the same scale formation as a boiler. The circulation of the water in the economizer is slow and the impurities carried in suspension usually settle to the bottom and can be blown off at the blowoff valves. Usually there is sufficient temperature of outgoing feed water to deposit much of the impurities carried in the water. The scale-forming elements deposited on the tubes do not bake as hard on the economizer tube as in a boiler, on account of the much lower temperature to which the economizer tube is subjected, but usually the scale forming elements remain in the economizer in the form of a thick mud. If this muddy deposit is allowed to remain in the lower header, it will gradually slow up the circulation, sometimes to such an extent that steam will form in that section of the economizer. The only method to rid the economizer of this deposit is through the blowoff valves, and they should be so placed that the deposits will be removed from each section when blown down.

GAS TEMPERATURES

A KNOWLEDGE of the temperature of the stack gases entering and leaving the economizer is quite important for its successful operation. These temperatures may be obtained by means of a mercury, or electric pyrometer. A recording thermometer is always more desirable, as a chart is obtained and references may be

made to this record at any time. Moreover, from this record it is possible to determine quite readily such loss as is caused by air infiltration or dirty tubes. It is important that the proper location be chosen for inserting the pyrometer element in the gas flue. The elements for measuring the gas temperatures should be placed in the flue just immediately before and after the economizer. Care should be taken that the element is not placed behind the damper, or in some part of the flue where there is likely to be a pocket of dead gas. Generally in the middle of the flue is the best location for inserting the pyrometer. It is important that the hole in the gas flue through which the pyrometer element is inserted be well sealed, to avoid air infiltration into the economizer, and thereby incorrect temperature readings.

Water Temperatures

Water temperature into and out of the economizer may be read from a mercury thermometer placed in the inlet and outlet water pipes. As in the case of obtaining gas temperatures, it is more desirable that recording thermometers be used in obtaining the water temperatures, particularly in the case of the outlet temperature, for both mechanical and economical reasons.

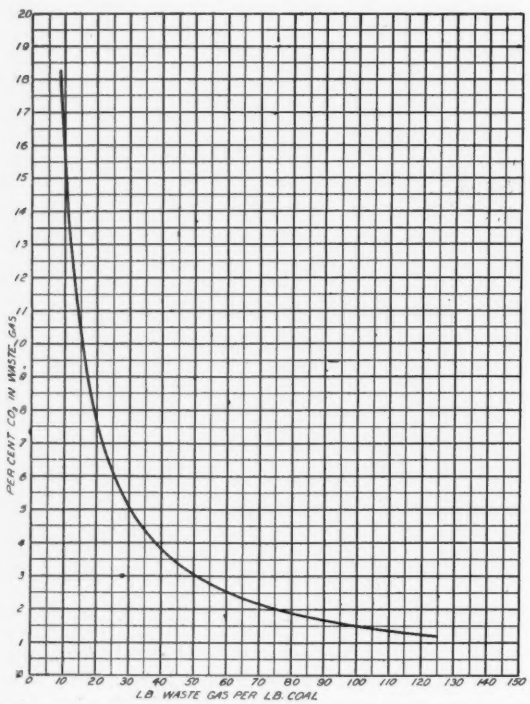


FIG. 1. POUNDS OF WASTE GAS PER POUND OF ILLINOIS COAL FOR VARIOUS PER CENTS OF CO_2

The main object of the economizer is to heat the feed water, and no economizer is complete without at least a thermometer in the water outlet for without it the operator has no idea how efficiently the economizer is performing its function. From a mechanical standpoint it is not desirable to operate an economizer under conditions such that with either a slight rise in the temperature or increase in weight of waste gases steam would form in the economizer itself; therefore another reason for having a permanent record of the outlet water temperature.

Gas Volume

Volume of gas entering the economizer may be calculated by two methods. First by the direct method, by calculating the weight of waste gas per pound of coal and multiplying this result by the pounds of coal burned per hour. Second, by the indirect method which consists in dividing the heat put into the feed water by the product of the drop in gas temperature through the economizer and the specific heat of the waste gas. The indirect method necessitates, of course, a water meter which measures the quantity of feed water going through the economizer.

The following calculation shows the method of arriving at the weight of waste gas per lb. of Illinois coal. Assume the coal to have the following proximate analysis: Fixed carbon, 38.7 per cent; volatile, 39.0 per cent; ash, 8.5 per cent; moisture, 13.8 per cent, and ultimate analysis as follows: Carbon, 60.0 per cent; H., 4.3 per cent; N., 1.2 per cent; O., 10.8 per cent; S., 1.4 per cent; ash, 8.5 per cent; moisture, 13.8 per cent. Also assume the analysis by volume of the waste gas entering the economizer to be 10.01 per cent CO_2; 9.6 per cent O.; 0.0 per cent CO. The weight of a cubic foot of carbon dioxide, CO_2, is 0.115,92 lb., and the weight of carbon in a cubic foot of CO_2 equals 0.0316 lb.

The weight of carbon in a cubic foot of the above waste gas equals $0.10 \times 0.0316 = 0.003,16$ lb. Therefore the cubic feet of dry waste gas per pound of coal equals $0.60 \div 0.003,16 = 190$ cu. ft. Weight of one cubic foot of waste gas equals 0.0783 lb., so that the pounds of dry waste gas per pound of coal is $190 \times 0.0783 = 14.9$ lb.

Along with the dry gas we have moisture from the coal itself and from the air supplied for combustion also moisture formed by burning the hydrogen. Moisture per pound of coal—

in natural coal	0.138 lb.
from hydrogen in coal $0.043 \times 9 = 0.387$	lb.
in air	0.075 lb.
Total	0.600 lb.

So that the total weight of waste gas per pound of coal burned to the above analysis equals $14.9 + 0.6 = 15.5$. Figure 1 shows different weights of waste gas per pound of Illinois coal for different per cents of CO_2.

Heat to Water

After calculating the waste gas volume and knowing the inlet and outlet temperatures of the waste gas there is now sufficient data to calculate the heat taken out of the waste gas by the economizer and the amount discharged to the stack. Taking the above data, 10 per cent CO_2 in the stack gas and Illinois coal and assuming that the waste gas has a temperature of 600 deg. F. when it leaves the boiler, the heat or B.t.u. contained in the waste gas can be calculated. The specific heat or heat required to raise 1 lb. of gas 1 deg. F. equals 0.25 B.t.u. There are 15.5 lb. of waste gas per pound of coal. Therefore the heat leaving the boiler in the waste gas, per pound of coal equals $15.5 \times 600 \times 0.25 = 2325$ B.t.u. In order to simplify the calculations zero degree F. air temperature is taken. Assume that the economizer absorbed sufficient heat to lower the waste gas temperature to 400 deg. F. Then the heat discharged to the stack equals $15.5 \times 400 \times 0.25 = 1550$ B.t.u. $2325 -$

1550 = 775 B.t.u. absorbed by the economizer per pound of coal.

Suppose in a boiler plant 2000 lb. of Illinois coal were burned per hour, under the above conditions, that is 10 per cent CO_2 and 600 deg. F. inlet gas temperature to the economizer and 400 deg. F. outlet gas temperature, also that 13,000 lb. of water at 125 deg. F. are fed into the economizer. It is desired to know the temperature of the feed water leaving the economizer. From the above, 775 B.t.u. are absorbed by the economizer per pound of coal, so that $775 \times 2000 = 1{,}550{,}000$ B.t.u. are absorbed. In this case let X equal the outlet water temperature from the economizer then—

$13{,}000 \times (X - 125)$ equals 1,550,000 B.t.u.

$X - 125 = 119$

$X = 244$ deg. F.

contained only 6.8 per cent CO_2 and was at 300 deg. F. It is desired to know the temperature of the feed water leaving the economizer and the amount of heat required to heat up the excess air which leaked into the economizer. From Fig. 1 we find the pounds of waste gas per pound of coal to be 22.5 for 6.8 per cent CO_2 in the gas. Heat in waste gas to economizer equals $2000 \times 15.5 \times 600 \times 0.25 = 4{,}650{,}000$ B.t.u. Heat in waste gas discharged to stack $= 2000 \times 22.5 \times 300 \times 0.25 = 3{,}375{,}000$ B.t.u. Heat taken up by the economizer equals $4{,}650{,}000 - 3{,}375{,}000 = 1{,}275{,}000$ B.t.u. If X equals the outlet water temperature from the economizer then $13{,}000\ (X - 125) = 1{,}275{,}000$ B.t.u. $X = 223$ deg. F. Air leakage into the economizer $= 22.5 - 15.5 = 7.0$ lb. of air for every pound of coal burned or $7 \div 0.080{,}728 = 86.8$ cu. ft. of air at 32 deg. F. This air was heated up

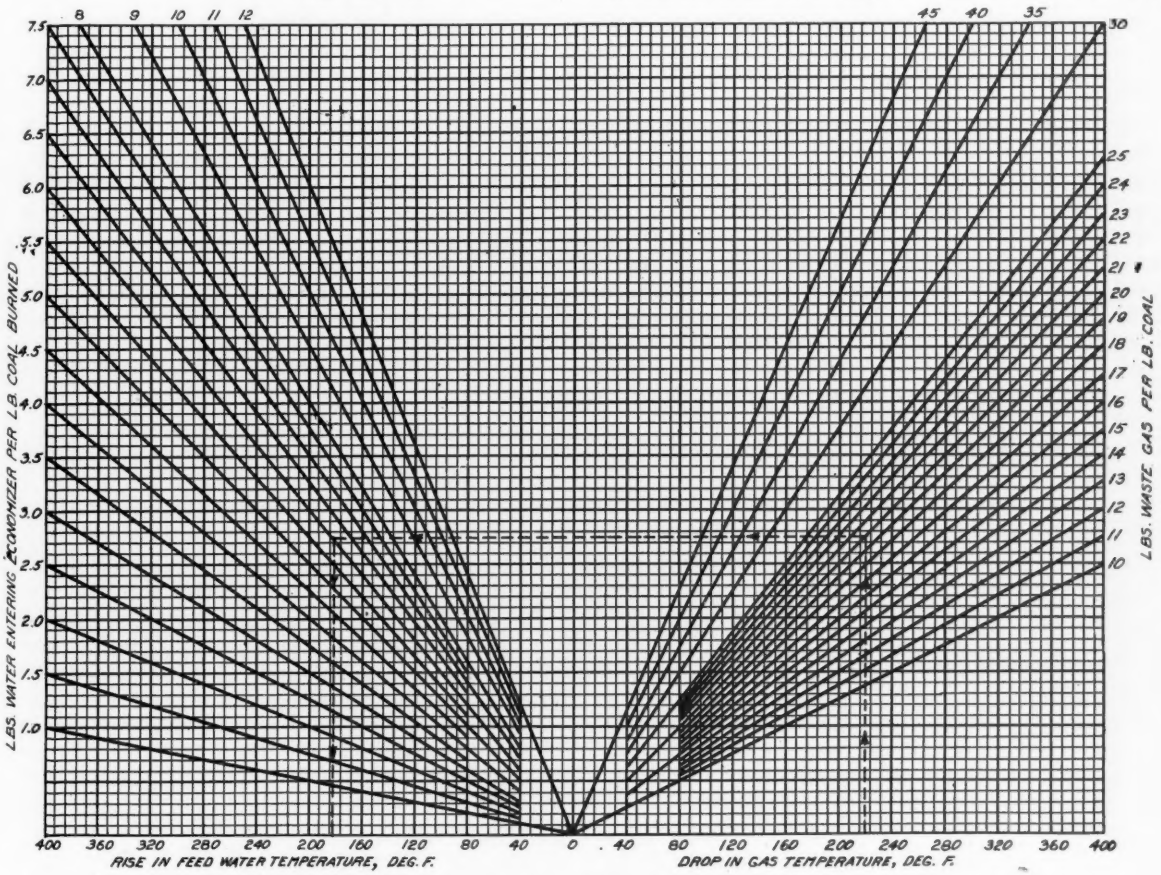

LBS. WATER ENTERING ECONOMIZER PER LB. COAL BURNED
LBS. WASTE GAS PER LB. COAL
RISE IN FEED WATER TEMPERATURE, DEG. F.
DROP IN GAS TEMPERATURE, DEG. F.

FIG. 2. RELATION OF HEAT GIVEN UP BY GASES TO HEAT ABSORBED BY FEED WATER

Air Leakage

While the inlet gas temperature may be 600 deg. F. and the outlet gas temperature 400 deg. F., this drop in temperature may not be due entirely to heat absorption by the water in the economizer, as there may be considerable heat given up by the waste gas to heating air which leaks into the economizer. In fact, air infiltration is an important thing to guard against for economical operation. Suppose as above that the waste gas entering the economizer contained 10 per cent CO_2 and was at 600 deg. F., but that while passing through the economizer the waste gas became diluted with air, infiltrated through the setting, to such an extent that it to a temperature of 300 deg. F. before it was discharged along with the other gases to the stack. Then the B.t.u. required to heat the excess air equals $2000 \times 7 \times 300 \times 0.25 = 1{,}050{,}000$.

It is thus readily seen that low outlet gas temperature does not necessarily mean economical operation of the economizer. For in this particular case nearly as much heat went to heating up the infiltrated air as was absorbed by the water. If the heat to the air had also been absorbed by the water then $13{,}000\ (X - 125) = 2{,}325{,}000$ B.t.u. and X would equal 304 deg. F.

Another effect of infiltrated air is that it tends to overload the stack or if induced draft is used it puts

additional work on the fan, consequently requires more horsepower to furnish sufficient draft.

The economizer, due to its peculiar construction of headers, dampers, etc., offers many opportunities for air leakage. The economizer should be well examined for air leakage and frequent checks on the analysis of CO_2 in the entering and exit gas should be made. A reasonable drop of from 1 to 2 per cent CO_2 in the gas may be expected while passing through the economizer. These samples of waste gas should be drawn over a considerable period of time, at least 15 min., and should be taken simultaneously. If they are not drawn at the same time they may not be representative analysis of the same gas and incorrect conclusions might be made from the results.

Use of a torch or candle is perhaps the simplest method of determining air leaks. Particular attention should be given to cleaning doors, damper shafts and around the top of the economizer. The gas flue between the economizer and the boilers should also be well examined for air leakage. There are many preparations in the market for covering brick work to prevent air infiltration and many of them give excellent results.

Rate of Heat Transfer

Figure 2 is a curve showing the relation between heat given up by the gases and heat put into different amounts of feed water. The method of using the curve is illustrated on the curve itself by means of the dotted line. This curve was calculated on the assumption that there was no air leakage into the economizer. Suppose the gas temperature drop is 240 deg. F. and that pounds of waste gas per pound of coal is 20, also that 6 lb. of water are entering the economizer, per pound of coal burned in the boiler grate. Read vertically on the chart from 240 to the line marked 20 lb., then extend horizontally to the line marked 6 lb. Vertically below where this horizontal line and the 6-lb. line intersect we read 200 deg. F. This means that under the above conditions the economizer should raise the temperature of the water 200 deg. F. If it fails to raise the temperature of the water 200 deg. F., then it is evident that the economizer needs attention; it is probable that excess air is being drawn into the economizer and that some of the heat in the gas is being required to raise the temperature of this air instead of the water.

The quantity of heat, expressed in terms of B.t.u., passing through 1 sq. ft. of economizer heating surface per hour per degree mean temperature difference between the gas and water is known as the rate of heat transfer. The rate of heat transfer usually ranges from 4 to 8 for boilers and is considerably less for economizers running from 1.5 to 4. Clean tube surfaces both inside and outside, together with high gas velocity are quite important for high rate of heat transfer in the practical operation of an economizer. Usually the gas velocity in a permanent installation depends upon the load demand and cannot be changed, but the bad effect of dirty tubes on the rate of heat transfer can be kept to a minimum by careful attention.

Considerable work has been done on the law governing the rate of heat transfer as affected by the gas velocity in boilers. Gas velocities have been expressed in various forms, one being weight of gas per hour (W) divided by square feet of heating surface (A). These forms are used on account of the different shaped sections through which gas travels and the difficulty of calculating the actual gas velocity over these surfaces. Much the same difficulty is experienced in calculating the gas velocity in an economizer. Although usually the flow of gas is in a straight horizontal direction in the economizer, still for the same weight of gas there are various velocities due to whatever the temperature of the gas may be. As the gas passes through the economizer, its temperature is lowered, consequently its velocity, if the economizer maintains the same cross-sectional area. The rate of heat transfer varies as the velocity of the gases, therefore varies directly as the weight of gases per hour and inversely as the size of the economizer.

In the economizer the limit of gas temperature reduction is the inlet temperature of the feed water.

In determining the economical size of economizer, the value of heat recovered from the waste gas less the fixed charges on investment for the economizer and the cost of the fan installation and operation or the value of additional stack capacity, governs the size of economizer. Usually 4 to 5 sq. ft. of economizer heating surface is allowed per rated boiler horsepower of the boilers supplying waste gas to the economizer. Allowing 10 sq. ft. of heating surface per boiler horsepower this would give a ratio of economizer heating surface to boiler heating surface of 0.4 to 0.5. Depending on the cost of fuel and the per cent rating at which the boiler operates, the ratio of heating surfaces of 0.75 might be found to be economical.

The following calculation is taken from data published on the results of tests on economizers:

Test number	1	2
Sq. ft. heating surface in boiler	9500	10,500
Sq. ft. heating surface in economizer	4750	4610
Ratio economizer H.S. to boiler H.S.	0.5	0.44
Lb. coal burned per hour	4850	1360
Lb. waste gas per lb. coal	21	30
Lb. of waste gas per hour	102,000	40,800
Inlet gas temperature deg. F. $= T_1$	535	370
Outlet gas temperature deg. F. $= T_2$	325	245
Inlet water temperature deg. F. $= t_1$	70	105
Outlet water temperature deg. F. $= t_2$	205	205
Temp. difference between inlet gas and inlet water $T_1 - t_1$	465	265
Drop in temperature between inlet and outlet gas $T_1 - T_2$	210	125
Per cent drop in gas temperature of total possible temperature drop, $T_1 - T_2 \div (T_1 - t_1)$	45.1	47.2
Mean specific heat of gases	0.25	0.25
Mean temperature difference between gas and water, deg. F.	293	151.8
B.t.u. transmitted to economizer from the waste gases	5,400,000	1,280,000
Rate of heat transfer in B.t.u. per sq. ft. heating surface per degree mean temperature difference between gas and water	3.9	1.82

Both tests were on the same make of economizer.

Condition of the surfaces of the tubes in these tests was not stated, but it is probable that in both tests the condition of the tubes was good. In test No. 2 the rate of heat transfer was much lower than in test No. 1, no doubt due to greater weight of gases, and therefore

higher gas velocity in test No. 1 than No. 2. The per cent temperature drop of the total possible temperature drop of the gas is approximately the same for both tests. In actual practice this per cent is usually from 45 to 55 for economizers and is much lower than is obtained for steam boilers.

In conclusion, it might be well to enumerate again some of the essentials for high economizer efficiency. First the tubes must be kept clean, both inside and outside. Deposits on either side lowers the rate of heat transfer and sends more heat to the stack. Soot on the outside of the tube indirectly causes corrosion and increases the draft loss through the economizer, which in case a fan were required to remove the waste gases, adds to the cost of fan operation. Second, the air infiltration must be kept to a minimum. Very poor results are obtained if the economizer setting is not in good condition and allows air infiltration into the economizer. Any infiltration of air places additional load on the fan.

Worcester's Fuel-Saving Campaign---III

PERSONNEL AND WORK OF FACTORY COMMITTEES. BY S. E. BALCOME

IN THE following article the writer will tell of the organization and workings of the individual shop committees spoken of in previous installments. These committees were organized in all of the large factories and in most of the smaller ones. The inspectors were picked from the largest fuel consumers because they would naturally want to make a good showing at their own plant, and as the plants represented by these men use 50 per cent of the total amount of coal used in Worcester, there would be obtained a substantial serving anyway.

In shops where many people are employed the committees were composed of a number of men, these men being picked out for their knowledge of the different methods of using power and steam, and in part because they were men who had proven themselves interested in their work. These large committees were composed of as many as 70 men, not many concerns having as many as that, however.

These organizations would have been, without doubt, modified to some extent if the necessity for their existence had remained, as many of them were too cumbersome to be very efficient.

The factory at which the writer is employed uses about 50 tons of coal a day in the winter months and employed at the beginning of the winter over 3000 people in their Worcester factory. The committee was composed of 70 men, some of whom were foremen, but as a rule foremen were not invited to serve as their time and attention is supposed to be taken up by their own work. The proceedings of that particular committee were as follows:

First, a meeting was called of the entire committee which was told of the proposed scheme and of the part of each member in the work. An outside speaker who has considerable knowledge and experience in the generation of heat and power was there and gave them a very interesting and instructive talk on some of his experiences, which had the effect of making them acquainted with the work they were to do and also of imparting to them some enthusiasm. They were then given a short talk by the chairman of the committee who told them that records were kept of the amount of steam and electricity generated daily and any saving they could make would, of course, show on these records.

It was the intention of the chairman to make a curve showing the daily steam consumption and another one showing the electricity used and have it posted in a conspicuous place where all could watch it.

Cards were passed around to the men on which were printed directions, telling them what to look for, and also, forms on which to write their recommendations. These recommendation were sent to the chairman of the committee who looked them over and if he thought they were practical, sent in a regular order to the maintenance department to have the work done. The recommendations were for any change in apparatus or repairs to any part of the building or apparatus which they thought would effect a saving of heat or power.

This certainly brought results for the first few days, recommendations coming thick and fast, and most of them of practical value. Many of them pointed out uncovered steam pipe, others mentioned windows that were obstructed by boxes, barrels and other things being piled up against them, shutting off the light, and others spoke of shafting running idle, unpainted and darkened walls, etc.

The boiler and engine rooms and adjacent rooms were taken care of by the engineers, of which there are four. The supply of hot water, care of steam pumps and heating system also came under their care. To effect economy in heating building and rooms, one man was appointed to regulate the temperature of the offices and factory rooms.

At another factory a committee of twelve men was formed, among which were the electrician, engineer and steam fitter. These men held regular weekly meetings, at which questions were brought up, recommendations and repairs discussed and passed upon. Whenever any recommendation for repairs or change was not followed out and finished, it was brought up in the meetings and the man who was responsible for that particular job was required to give a reason why it was not finished. Thus everything was done that should be done.

This seemed to be a very satisfactory way of managing a shop committee.

At still another factory a committee of about twelve or fifteen men were appointed, and then they were divided into seven small committees, as follows: General Factory Committee, Committee on Coal Burning, Steam Consumption, Heating, Electric Power, Fuel Oil, and Night Conservation committees. They were composed of three or four men each, and some of the men served on more than one committee. These men also met weekly

to report progress. Complete records were kept at all of these meetings.

Now as to preventing wastage of fuel, a word might not be out of place at this time.

Fuel and Power Saving

(Room Committee)

OBJECT OF THESE COMMITTEES:

To save 20% of the coal pile in this factory this year.

WHY THIS MUST BE DONE:

Because the war will cause a shortage of at least **six million tons** of steam coal in New England this year. 20% saved in every factory and building will make good this shortage and reduce the number and length of shut downs

HOW IS IT TO BE DONE:

Let all officers and employes work together to save heat and power, for these all come from coal.

Help the Committee by cheerfully complying with their plans.

Watch pulleys, belts and shafting which are running idle.

Watch for leaks in steam and hot water pipes.

Watch for defect in hot air heating apparatus.

Watch for broken windows, poorly fitted doors and windows, worn thresholds, rotted or rusted ventilators.

Report outside doors not provided with door checks or springs for keeping them closed in cold weather.

Report cases when outside openings in stair towers and elevator shafts are not kept closed

See that the temperature of your room is kept at *68* degrees.

See that electric lights are turned out when not in use.

See that hot water is not wasted.

See that steam is shut off on sewing machines when they are not in use.

See that no drinking bubbles are locked open. (It takes power to cool water)

See that temperature is dropped in rooms not used at night.

See that windows and electric light bulbs and reflectors are clean.

See that live steam is not wasted in the restaurant, building A, 1st floor and second floor; building D and other places where it is used

See that ventilators are closed at night in *office.*

Watch for machines running idle and see that belts are thrown off or clutch thrown out.

See that the current is turned off on electric heater units when they are not in use

Report anything that you think will help save Fuel and Power to the General Committee.

[redacted] MFG. CO.,
FUEL & POWER SAVING COMMITTEE
[redacted] Secretary.

FIG. 1. REPRODUCTION OF CARD HANDED TO EMPLOYES

FUEL & POWER SAVING REPORT

Date Dept.

Floor Bldg.

Recommendations

Reported by

Send this Report to [redacted]

FIG. 2. BLANK FORMS FOR SUBMITTING RECOMMENDATIONS

A great deal of the waste is due to letting down the bars; that is, allowing the plant to run down. Repairs are made very speedily when the main shaft breaks, but when, for any reason a section of pipe covering is taken off or is knocked off, ten chances to one it is not put on again for the simple reason that everything runs along just the same and, of course, no one can see the loss of heat which is going on all the time from that bare pipe. It is the same with steam traps, blowoff valves, and other places where leaks can occur without being seen.

This idea also should be kept in mind, that it is not good practice to let either exhaust or live steam go to waste into the atmosphere. By a correct arrangement of the power load and the steam requirements, all of the steam generated can be used.

This could be accomplished by buying electric power at times when steam is not needed.

There are some difficulties in the way of doing this at the present time, but the time will come when it may be done and much of the machinery that is given power now by burning coal, which is carted thousands of miles will be run by power from the rivers of the country, many of which are now wasting their power for want of development, or from highly efficient power stations located at the coal mines.

An Over Supply of Clerical Workers

"ACCORDING TO Captain Felton, who is handling the discharged soldiers, the employment service is having little difficulty placing in employment men with trades, but difficulty is being experienced in placing those who merely have clerical ability and training." That statement was made in a weekly report on the Washington branch of the United States employment agency engaged in finding work for the men being discharged from army and navy. It is confirmed by reports from other branches. It is a fact that cannot be either minimized or disregarded, for it is at the same time a guide post and a warning. It puts concretely what most people had vaguely surmised before but had paid little attention to, and that is, too many young people are rushing into clerical occupations, such as bookkeepers, stenographers, office men, store help, accountants, and the like. This work is poorly paid because of an over supply of those who are in that line. Labor and skill are commodities, and when the market is over stocked, generally prices fall.

There must be more vocational education. More people must be taught to do creative things. For such, we see there is a ready welcome by employers. The federal board for vocational education at Washington is teaching disabled soldiers to do creative things, to work despite their handicaps, in the skilled trades, which afford steady employment at good wages, and is having no difculty whatever in placing men who are taking courses in creative work. The really skilled and able artisan is rarely affected by slack times, and is always sure of a job.

Correction Note

IN THE article by Roger Taylor entitled Steam Expansion, published in the March 1, 1919, issue, for some unaccountable reason Tables I and II were transposed so that the figures given for the Carnot cycle, page 234, are, in fact, the values for the Rankine cycle, and vice versa.

THE VALUE of life is to improve one's condition.
ABRAHAM LINCOLN.

EDWIN MUSSER HERR

WHILE WORKING AS TELEGRAPH OPERATOR IN COLORADO HE PREPARED FOR FUTURE TECHNICAL TRAINING; LATER BECAME ACTIVE IN RAILWAY ENGINEERING; NOW NOTABLE EXECUTIVE. BY M. EMMILINNE PITT

SUCCESS, achievement, and distinction, after all, are alone for men who consider wisely, resolve firmly and execute with inflexible purpose and promptness. With the great reconstruction period already across the threshold of our international life, men of America have already a destiny even greater than ever before in the industrial progress of the world. The great light of civilization can move forward, and be kept burning on the heights only by great leadership, and these leaders must come from our scientific and industrial life.

For young men, ideals are as necessary to guide their destiny as the north star was necessary in days of old to guide the sailor on the boundless sea. The stars that guide human progress are our great leaders of the past and present. Nothing under the sun energizes personality as does an acquaintance with the life of a leader of men.

Personality is that priceless, immortal treasure by which men are instinctively and intuitively distinguished as possessing those high inherent principles of manhood which eminently fit them for leadership in dealing with both destinies and men.

Earnestness of spirit, executive power, capacity and responsibility, as well as a deep knowledge and interpretation of human nature, its needs and aspirations, all these features of personal worth are found emphasized, and impress one in the personality of this man.

There is no virtue so much needed in the great world of business today as earnestness. The earnest man seldom fails to find success. Opposition seems to lose its substance when it grapples with it. With that same earnestness of spirit which characterized the procedure of our forefathers in framing the constitution, yet implicitly believing in highly concentrated power in scientific professional and industrial development, Mr. Herr has pursued his way to the pre-eminent place he holds today in the world leadership of great men —men upon whose shoulders devolved the tremendous responsibility of placing the master stroke in our recent international victory. Keeping pace and being able to cope with the rapid transformation which involved sweeping and important changes in our commercial and industrial life during the dramatic events of the war, in which the professional engineer played an important part, was by no means an easy task. Hand in hand, big men of the engineering profession worked for industrial success. As a result, today the public looks upon the engineer in a new light, as one of the important factors in the life and development of our country.

EDWIN MUSSER HERR

Mr. Herr was born at Lancaster, Pa., May 3, 1860 and began his career as a telegraph messenger and operator in Denver, Colorado. Later he held the position of station master and operator at Deer Trail, Colorado, and during those days of railroad service he prepared for his future professional training. His education was completed at Sheffield Scientific School, Yale University, from which he graduated as mechanical and scientific engineer, specializing in electricity in 1884.

His exceptional ability for executive work marked his entire college career. Shortly after his graduation Mr. Herr accepted a position in the power department of the Chicago, Milwaukee and St. Paul Railroad. At various times he also held responsible positions with the following concerns: Mechanical draughtsman and testing engineer, then superintendent of telegraphs for the Chicago, Burlington and Quincy Railroad, and master mechanic for the Chicago, Milwaukee and St. Paul Railroad. From 1890 to 1892 he held the superintendency of the Grant Locomotive Works of Chicago.

In 1895 Mr. Herr was sent as representative of certain financial interests to establish locomotive works in Russia. In 1896 he became general manager of the Gibbs Electric Co. in Milwaukee, and later was identified with the Chicago and Northwestern, and also the Northern Pacific Railroad.

Thoroughly skilled in all branches of mechanical engineering, Mr. Herr accepted the position of assistant

manager of the Westinghouse Air Brake Co. in 1898. A few years later he was promoted to general manager, which was rapidly followed by his election as vice-president and director. In 1905 Mr. Herr resigned from his official connection with the Air Brake Co. to assume the position of vice-president with the Westinghouse Electric & Manufacturing Co., taking full active charge of the manufacturing and commercial operations. August 1, 1911, by unanimous vote, Mr. Herr was elected president, succeeding Edwin F. Atkins of Boston, who had requested that he be relieved. And ever since his able leadership has been one of the salient forces in the success of that company.

In speaking of his close association with Mr. Herr over a period of six years, Vice-President L. A. Osborne said:

"Mr. Herr's keen sense of duty is one of his most prominent characteristics; his devotion to work is a tradition among Westinghouse employes; hours count for nothing if they can be devoted to the upbuilding of the interests of the company. He is among the earliest at work in the morning and of the last to leave at night and the intervening day's work is devoted systematically and continuously to constructive work. He seems to have an unusual degree of the proper balance between the important and the unimportant, and yet no details are to complex for him to master, if in his judgment it is important that he should do so."

Another important and admirable feature of Mr. Herr's personality is his absolute command over himself. In the face of most trying situations he has never been known to display impatience or temper. His keen sense of humor in detecting the ridiculous side of a question has often been the saving grace in relieving the strain of what would otherwise have been an unpleasant or embarrassing situation. He not only sees the humor in the affairs of others, but will laugh as heartily when the joke is on himself.

Mr. Herr, by his ability and through his wide experience in the world of industry, is a master psychologist, realizing the positive need for fairness of purpose in dealing between man and man. He has done much for the higher education of young men and for the general uplift of the workers.

Beyond question, Mr. Herr's greatest achievement is his contribution to the scientific world in the constructive work he has done in helping to develop the electrical industry to the high standard it holds today.

Poison gas, liquid fire, shrapnel, explosive shells, machine guns, rifle bullets, bayonets and men that fought like demons, showed no sign of the presence of the unseen force of electricity. Yet were it not for electricity and man's control of its use, these forces of victory had not been.

Electrically driven machine tools made possible what human sweat and muscle never could have accomplished. Unheard of tons of steel have been required, and those best able to judge have said that without electric drive to speed production in the mills we should have fallen short. Of these things, some were doubtless made by steam power unaided; but where production was the swiftest and therefore the most effective, electric drive was responsible. The chemicals that speeded the shells on their way, that burst the shell to fragments, that made the very air untenable for the foe, owed their production in the tremendous quantities required to electricity. Electrochemical processes fashioned some, electric drive furnished the controllable mechanical power for making others.

In its gentler aspects, electricity appeared even on the field of battle, guiding armies, battalions, even individual shells. The airman, by his wireless telephone and telegraph, guided the gunner far to the rear who otherwise would have been blind. The commander watched through his wire and wireless network the progress of his fighting units miles away, kept them correlated into one vast machine that acted as a whole, not as a multitude of unrelated parts.

Billions on billions of electric sparks daily ignited the cylinder charges of motor trucks, lorries, airplanes, motor cars, motorcycles and the victorious tanks. Without electricity for ignition these engines would have been unheard of. Electric light in battlefield searchlights patrolled the sky. Within the busy plants men worked through long hours of night as swiftly as by day, because electric illumination was at hand.

Mr. Herr has been one of the strong forces in bringing the scientific engineer into his own among the foremost professions of the world.

During an address on "Personal Reminiscences" delivered before the young men of the Westinghouse Club, Mr. Herr told of the following incident which occurred during the early days of his railroad experiences.

"I had just been appointed to take charge of the St. Louis Division of the Chicago, Burlington and Quincy Railroad," said Mr. Herr, "and called upon my immediate superior, under whom I worked many years, to talk over the situation and also to get my bearings. I knew him to be a very able, shrewd man, who had made an intensive study of railroad problems. We chatted, and in fact, had a pleasant time together. Finally I arose to go, and asked him if he had any specific instructions to give me, to which he replied: 'Well, Mr. Herr, I have only this one piece of advice to give you. The road is running there now—*don't stop it* until you are sure you can start it again.' "

"I have never forgotten the great truth suggested in his advice," said Mr. Herr. "It was the best piece of advice I ever received. Frequently men who take charge of a place, hinder its progress by immediately discharging experienced men, putting in new systems, and otherwise upsetting things, so as to receive little or no co-operation from employes, and in addition making themselves generally disliked. To make men feel that they are 'making good' in their work is fundamental for best results and the most stimulating of human experiences."

But with all the infinite duties of his office as chief executive of a great manufacturing company, Mr. Herr finds time for the social side of life and also finds much pleasure in a spirited game of tennis or golf. He is a connoisseur of fine etchings, oriental tapestry and rugs, of which he possesses some of the rarest specimens.

Mr. Herr's successful career should be an incentive to the young men of his profession to follow his example. It should serve as an incentive from which to follow his lead onward to the very apex of ambition up to where the "Light lingers even after the sun is down."

Reliability of Large Turbines

SIGNIFICANT in the development of the electric power industry is the concentration of generating capacity. This is favored, first, by growth of industrial load, which centers about the cities, and second by the economic advantages of the large central station over the smaller one. At the present time there are six districts in the United States in which the maximum sustained peak load on all companies is above 150,000 kw. and one of these has a peak of 800,000 kw. These large and growing loads have put it up to the manufacturers to design generating units with regard to their full-load characteristics, and without limitations of size. With the rapid increase of size there has been a feeling in some quarters that the limits of good practice have been exceeded, and that safety and reliability had been sacrificed for economy.

That such is not the case, has been shown in a paper recently presented before the American Society of Mechanical Engineers by J. F. Johnson, engineer of the turbine department of a prominent manufacturer. Ten

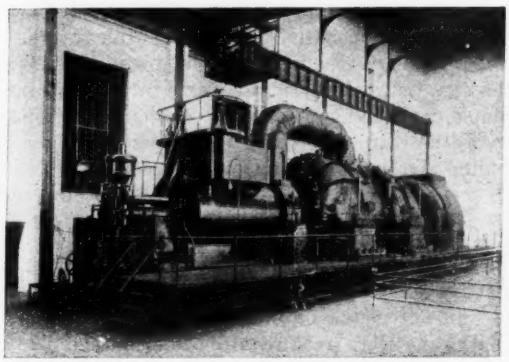


FIG. 1. 35,000 KW. TURBINE INSTALLED AT NORTHWEST STATION OF COMMONWEALTH EDISON CO.

machines of this company's make, from 30,000 to 70,000 kw. capacity, are now in service and have been in use for periods of from 1 to 5 yr. Their performance removes any doubt of the commercial practicability of such large units.

Three machines, of identical design, were installed in the East 74th St. power house of the Interborough Rapid Transit Co. in the years 1914-1915. They are rated at 30,000 kw. each and are of the two-cylinder cross-compound pure reaction type, the high pressure operating at 1500 r.p.m. with steam at 205 lb. and 120 deg. superheat, and the low pressure at 750 r.p.m. exhausting into a 29-in. vacuum. Two units have had no trouble of any sort and have been out of service only for periodical inspection and maintenance. On the remaining machine the labyrinth packing on the balance pistons of the high-pressure element has failed three times, requiring renewals of some parts. Investigation finally showed excessive lost motion in the thrust bearing and heavy distorting stresses, due to rigid bracing of the steam pipe near the turbine.

Another 30,000-kw. unit, installed in the Northwest station of the Commonwealth Edison Co. of Chicago in September, 1917, consists of a tandem compound, pure reaction type of turbine operating at 1200 r.p.m. with 220 lb. steam pressure, 200 deg. superheat, and 29-in. vacuum. After being in service a few hours the labyrinth packing on the low-pressure element failed, due to rigid piping between the two surface condensers, which prevented them from moving with the turbine casing, to which they are bolted. Temporary local repairs were made and the unit put into service. No further trouble, save a cracked expansion joint, has developed, and on one run the unit was in service for 71 days, being taken off the line only to clean the condensers.

At the Brunot's Island station of the Duquesne Light Co. a 40,000 kw. cross-compound machine has been in service since December, 1917. The high-pressure element operates at 1800 r.p.m. and the low-pressure element at 1200 r.p.m. This unit has been carrying loads of 30,000 to 40,000 kw. with peaks as high as 50,000 kw. In February the main bearing at the coupling end of the high-pressure turbine burned out, apparently due to interruption of its oil supply. This let the spindle down sufficiently to cause rather heavy blade rubs throughout the machine. After rebabbiting the bearing, the machine was put back into service, the only other work being rechecking clearances and placing a balance weight on the spindle to correct for weight rubbed off the blades.

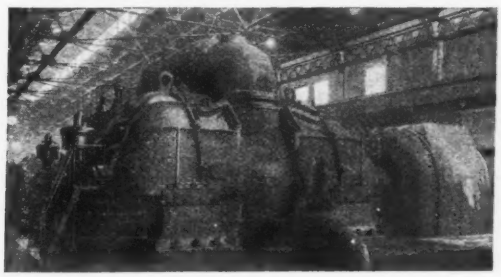


FIG. 2. DUQUESNE LIGHT CO. 40,000-KW. TURBINE GENERATOR

In July the generator was damaged by electrical trouble, and while this was being repaired, both elements of the turbine were dismantled, and a small amount of damaged blading was replaced.

Another unit, practically a duplicate of the preceding, but rated at 45,000 kw. was placed in service in the Providence plant of the Narragansett Electric Light Co. in January, 1918. Due to improper initial adjustment the labyrinth packing on the high-pressure element was damaged, requiring temporary repairs. Later, the couplings were distorted slightly by a series of violent short-circuits, together with defective workmanship in fitting the coupling keys. Permanent repairs to the packing have been completed, but the old couplings are still operating satisfactorily without signs of distress. Loads on this machine run as low as 5000 kw. and on peaks it carries 50,000 kw. for 5 min.

Largest of all is a 70,000-kw. three-cylinder machine, installed in the East 74th St. Station of the Interborough Rapid Transit Co. One low-pressure element was cut in on April 18, 1918, on high-pressure steam. The high-pressure element was put in service Aug. 21, and the second low-pressure on Oct. 9. On the first low-pressure element, lack of sufficient clearance on one spindle ring caused distortion and some intermittent vi-

bration. Later a few defective blades on the second low-pressure machine were replaced. The automatic devices for cutting out a defective element without disturbing the other two have been tried out with great success. This machine has carried loads of 55,000 kw. with swings up to 61,000 kw.

While these records do not show 100 per cent in all respects, they do show that in no instance has there been any evidence of basic defects in design, or inherent difficulties in operation. Troubles have all been of minor character, due to avoidable defects in details, such as are found in new apparatus of any sort or size. Satisfactory performance of these units has been due to the designers' insistence that reliability and general operative excellence should come first, efficiency second and cost third.

Estimating Hardness in Water

By Mark Meredith

THE amounts of reagents required for softening water by the lime-sodium carbonate and lime-sodium hydroxide methods may be calculated from the total hardness and the carbonate-hardness, non-carbonate hardness, and magnesia hardness, respectively. In determining the total hardness by Blacher's method with potassium palmitate solution, according to H. Noll, zinc and iron do not interfere with the process, as stated by Zink and Hollandt, provided they are first precipitated by means of sodium hydroxide.

The carbonate hardness is determined by titrating the water with standard acid, with methyl orange as indicator, and the magnesian hardness by the following modification of the method of Froboese—100c.c. of the water is rendered neutral to methyl orange with hydrochloric acid, then boiled for 10 min., treated with 5c.c. of a saturated solution of sodium oxalate, and again boiled for 1 to 2 min. After the precipitate has subsided, the liquid is titrated with N 10 potassium palmitrate solution with phenolphthalein as indicator. The number of cubic centimeters required multiplied by 2.8 gives the magnesian hardness in German degrees (one German degree=40 mgrms. CaO per 100c.c.). The carbonate hardness multiplied by 10 gives the amount of lime in mgrms. per litre of water required to convert bicarbonates into carbonates, while the magnesian hardness multiplied by 10 gives the amount of lime (mgrms. per litre) required to convert the magnesian carbonate into hydroxide and magnesium chloride and sulphate into the corresponding calcium salts. The non-carbonate hardness multiplied by 19 gives the amount of sodium carbonate required (mgrms. per litre), but in practice it is necessary to add an additional 10 to 20 per cent. As a rule, water rich in salts requires a smaller excess than a water containing a small amount of salts. The same data are used for calculating the amounts of reagents required for the lime-sodium hydroxides process.

In the case of a water in which the carbonate-hardness, excluding magnesian hardness, is greater than the non-carbonate hardness, the latter multiplied by 14.3 gives the mgrms. of sodium hydroxide required per litre, while the sum of the carbonate and magnesian hardness, less the non-carbonate hardness, multiplied by 10 gives the amount of lime required. To give the necessary excess of sodium carbonate the amount of sodium hydroxide should be increased and that of the lime reduced by quantities corresponding with 1 deg. of hardness, and for this purpose sodium carbonate must be added to waters in which the carbonate-hardness does not exceed the non-carbonate-hardness by at least 1 deg. Where the combined hardness due to carbonates and magnesium salts is greater than the non-carbonate-hardness, while the carbonate-hardness is equal to or less than the non-carbonate-hardness, the amount of sodium hydroxide required is obtained by multiplying the non-carbonate hardness by 14.3, and the lime by subtracting the non-carbonate-hardness from the sum of the carbonate and magnesian hardness and multiplying by 10. In the presence of magnesium bicarbonate in waters of this type, sodium carbonate should be added in a proportion corresponding with 1 deg. (=19 mgrms. per litre).

In the case of waters in which the combined carbonate and magnesian hardness is equal to the non-carbonate hardness, the latter multiplied by 14.3 gives the required amount of sodium hydroxide. In this case no lime is required and an excess of sodium carbonate must be added to the water. In the case of waters in which the combined carbonate and magnesian hardness is less than the non-carbonate-hardness, the sum of the carbonate and magnesian hardness multiplied by 14.3 gives the sodium hydroxide; the carbonate plus the magnesian hardness, less the non-carbonate hardness, multiplied by 19 gives the required amount of sodium carbonate. For softening alkaline water lime only is required.

Standard Blowoff Valves

MANUFACTURERS of blowoff valves held a meeting recently in New York in an effort to reach an agreement on standardizing their product so as to do away with freak requirements and simplify manufacture and supply of repairs.

As a result, several recommendations were made. First, that nothing smaller than 1-in. nor larger than 2½-in. is to be made for bottom blowoffs, in accordance with the A. S. M. E. Boiler Code. For intermediate sizes, 1½-in. and 2-in. only are to be made.

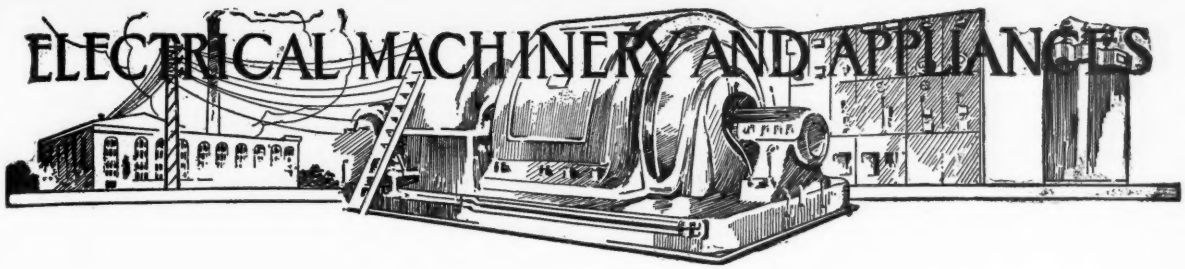
Second, for power boilers up to 250 lb. only extra heavy pattern valves are to be used, the 1-in. with screwed connections, 1½ and 2-in. screwed or flanged, 2½-in. flanged only; flanged connections are to be preferred for the 1½ and 2-in. sizes.

These recommendations, when agreed upon by all manufacturers, are to be submitted to the Industry Committee on Valves and Pipe Fittings for approval.

Warning

When any person or company tries to get you to exchange your Liberty Loan Bonds for any other stock or security, it is probable that he is a swindler, and it is certain that he is working for his own benefit, not for yours. Mail his name and address and any letters or circulars he may have sent to the Federal Trade Commission, Washington, D. C.

Abraham Lincoln said: "Answer with facts, not arguments." Don't argue about your patriotism. The war job has to be finished. Buy Thrift and War Savings Stamps.



A Study of Dynamo Electric Machinery---I

UNITS OF CURRENT AND ELECTROMOTIVE FORCE; CREATION OF ELECTROMOTIVE FORCE AND FACTORS INVOLVED. BY OTTOMAR H. HENSCHEL

FLOW of electricity is referred to as electric current, the unit of measurement of which is the ampere, ordinarily designated by the letter I and defined as "the practical equivalent of the unvarying current which, when passed through a solution of nitrate of silver in water, in accordance to standard specifications, deposits silver at the rate of 0.001,118 gram per second." It is the current that will flow through a conductor having a resistance of 1 ohm, that is the resistance at a temperature of 0 deg. C. (32 deg. F.) of a column of mercury 3½ ft. long and having a cross-sectional area of 0.0015 sq. in., and a difference of potential of 1 volt between its ends. The instrument ordinarily used for the measurement of current flow is the ammeter.

As in the case of water, or in fact any fluid, circu-

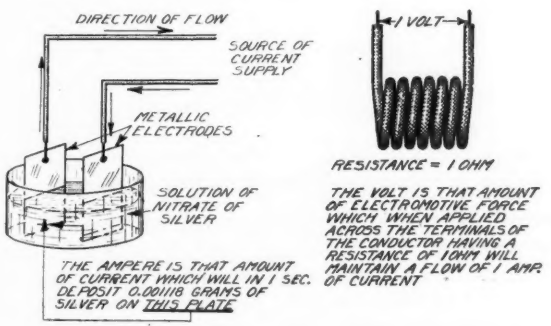

DIRECTION OF FLOW
SOURCE OF CURRENT SUPPLY
METALLIC ELECTRODES
SOLUTION OF NITRATE OF SILVER
THE AMPERE IS THAT AMOUNT OF CURRENT WHICH WILL IN 1 SEC. DEPOSIT 0.001118 GRAMS OF SILVER ON THIS PLATE
1 VOLT
RESISTANCE = 1 OHM
THE VOLT IS THAT AMOUNT OF ELECTROMOTIVE FORCE WHICH WHEN APPLIED ACROSS THE TERMINALS OF THE CONDUCTOR HAVING A RESISTANCE OF 1 OHM WILL MAINTAIN A FLOW OF 1 AMP. OF CURRENT

FIG. 1. ILLUSTRATING MEANS EMPLOYED IN DETERMINATION OF UNIT CURRENT AND UNIT ELECTROMOTIVE FORCE

lation or flow of electricity, can only be established and maintained by the application of a force or a pressure which, in the parlance of electrical engineering, is generally referred to as electromotive force or voltage, and ordinarily designated by the letter E. The unit of such electromotive force is the volt, that intensity of pressure, which, when steadily applied to a conductor having a resistance of 1 ohm, will establish and maintain a flow of 1 amp. of current.

In practically all commercial work, the instrument employed for the measurement of voltage is the voltmeter; for the finer degrees of measurement the millivoltmeter is used.

From the above statements, relative to the values of unit current and unit electromotive force, it is evident that a definite relation must exist between the resistance of a conductor, the current flowing through it and the applied voltage. This relationship (Ohm's law) is that the current flow in amperes is equal to the electromotive force in volts, divided by the resistance in ohms, which, if we represent the current flow by I, the electromotive force by E, and the resistance by R, may be expressed by this formula:

$$I = E \div R.$$

Or, transposing we may have

$$E = I \times R$$

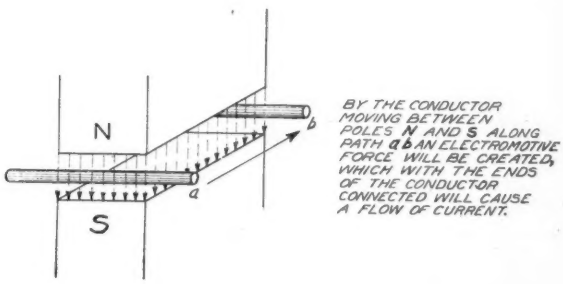
and

$$R = E \div I$$

if knowing the value of the electromotive force and current we desire to solve for R.

POWER

IN ELECTRICAL ENGINEERING the unit of power is the watt, the rate at which work is done when a current


N
S
a
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BY THE CONDUCTOR MOVING BETWEEN POLES N AND S ALONG PATH ab AN ELECTROMOTIVE FORCE WILL BE CREATED, WHICH WITH THE ENDS OF THE CONDUCTOR CONNECTED WILL CAUSE A FLOW OF CURRENT.

FIG. 2. HOW ELECTROMOTIVE FORCES ARE CREATED

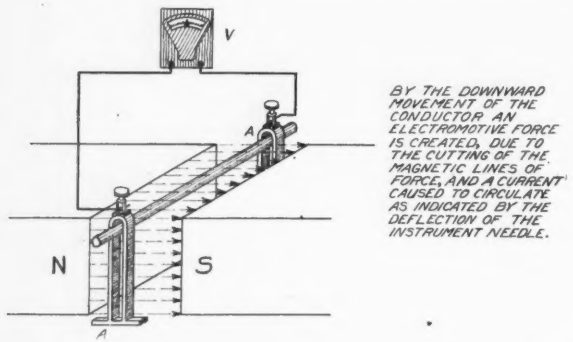
flow of 1 amp. is maintained under an electromotive force of 1 volt. Numerically power in watts is equivalent to the product of the instantaneous values of electromotive force and current, and generally for sake of convenience is expressed in kilowatts (1000 watts). If, therefore, we let W represent the number of watts and E and I respectively the values of the electromotive force and current, we have, $W = E \times I$ or, with W' representing kilowatts, $W' = (E \times I) \div 1000$.

Seven hundred and forty-six watts are equivalent to one electrical horsepower.

CREATION OF ELECTROMOTIVE FORCE

GENERATION of electromotive force may be accomplished by means of thermocouples, by chemical reactions in batteries or by electromagnetic induction, the principle underlying the operation of all dynamo electric machinery.

If by means of the hand an electrical conductor is, as shown in Fig. 2, caused to move perpendicular to a magnetic field, that is, caused to "cut" or "shear" the magnetic lines of force* emanating from one of the poles of a magnet, a difference of electric potential will be made to exist across the terminals of the conductor. Employing the arrangement shown in Fig. 3, whereby the conductor is made to pass across the magnetic field between the poles N and S, but by means of the slotted insulated metallic upright guides A A carried in its


V
A
N
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A
BY THE DOWNWARD MOVEMENT OF THE CONDUCTOR AN ELECTROMOTIVE FORCE IS CREATED, DUE TO THE CUTTING OF THE MAGNETIC LINES OF FORCE, AND A CURRENT CAUSED TO CIRCULATE AS INDICATED BY THE DEFLECTION OF THE INSTRUMENT NEEDLE.

FIG. 3. METHOD EMPLOYED TO DEMONSTRATE PRINCIPLE OF ELECTROMAGNETIC INDUCTION

downward movement to be in electrical contact with voltmeter V, this difference of potential will, due to the completed electric circuit, establish a momentary flow of current, as indicated by the deflection of the instrument needle.

Intensity of electromotive force or value of voltage thus created, is dependent upon three factors, the strength of the magnetic field, the number of conductors cutting this field and the velocity of travel of the

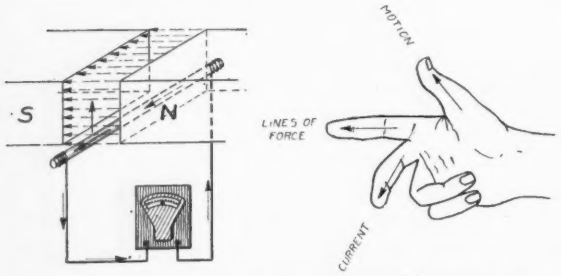

FIG. 4. APPLICATION OF FLEMING'S RULE

conductor or conductors. Varying anyone or all of these factors will result in a proportionate variation of the electromotive force.

Knowing the direction of travel of the conductor and the direction of the magnetic lines of force, the direction of the electromotive force may be readily determined by the application of Fleming's rule. Extend the thumb, the first finger and the middle finger of the right hand so as to bring them at right angles to one another. Then, with the hand held in a position causing the thumb to point in the direction of motion of the conductor, and the first finger in the direction of the magnetic flux, the middle finger will point in the direction of the induced electromotive force.

The principle of this is illustrated in Fig. 4.

The Elementary Generator

Practical application of the principles of electromagnetic induction, may perhaps, be more readily understood from a study of the elementary electric generator. Shown in Fig. 5, are the two poles, N and S, of a magnet so arranged and with faces of such form as to allow revolving between them, a coil CC′ mounted on shaft sh and connected as indicated to two collector rings R.R, also carried by shaft sh. Bearing upon each of the collector rings, are brushes B and B joined by suitable conductors to voltmeter V.

With shaft sh set in rotation, coil CC′ will revolve, and in doing so, will cut or shear the magnetic lines of force, passing from pole N to pole S, thereby creating an electromotive force, which will vary in degree of intensity and direction, according to the rate of rotation (or the rate at which the magnetic lines of force are being cut) and the direction of rotation of the con-

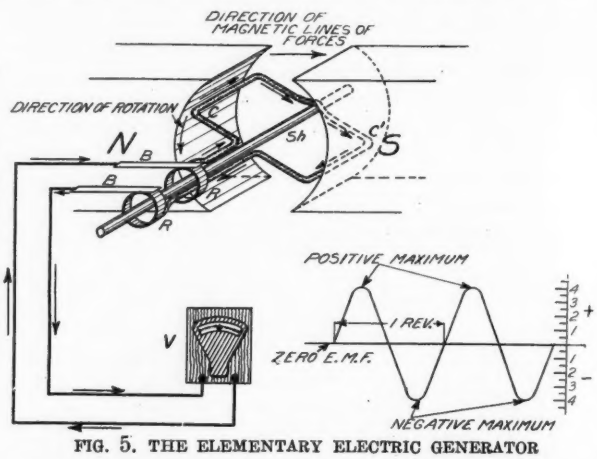

FIG. 5. THE ELEMENTARY ELECTRIC GENERATOR

ductors with reference to the direction of the magnetic lines of force.

As the coil passes through a vertical plane, no magnetic lines of force are being cut, and as a consequence, no electromotive force is induced. However, as conductors C and C′ pass out of the vertical plane, magnetic flux is encountered, which in relation to the position of the conductors, increases in intensity, until a horizontal plane is reached where the maximum number of lines of force are being cut, and a corresponding maximum electromotive force created. Further rotation of the coil brings conductors C and C′ through a decreasing magnetic field, which in turn results in a decreasing electromotive force.

After again passing through the vertical plane, the conductors encounter an increasing magnetic field, and while the resulting electromotive force as before, first increases and then decreases in intensity, the direction of this electromotive force, due to the change in direction of motion of the conductor relative to the direction of the magnetic lines of force is changed.

Connecting voltmeter V as shown, and plotting the readings of this instrument as the coil revolves, will provide a curve similar to that produced in Fig. 5.

*The magnetic line of force, the unit of magnetic flux or quantity of magnetism will be defined and discussed in the following installment of this series.

With the conductors leaving the vertical plane, the electromotive force will gradually rise until the maximum magnetic flux is being cut, when the electromotive force will reach a maximum value and decrease as the coil again moves towards the vertical plane. Upon reaching this, the electromotive force will again be zero, only, however, to increase, but in the opposite direction, as the coil continues to move toward the other horizontal plane, after which the electromotive force will decrease assuming a zero value upon reaching the vertical plane.

This explains the principle of operation of the electric generator and particularly so the alternating-current machine.

Calculation of Electromotive Force

When an electric conductor moves across a magnetic field at such a rate as to cut 100,000,000 lines of force per second it will have induced within it an electromotive force of 1 volt. If, therefore, two conductors connected in series are caused to cut 200,000,000 magnetic lines of force per second, or if four conductors connected in series, cut 100,000,000 lines per second, the induced electromotive force will in each case, equal 4 volts.

With E representing the value of the average number of volts induced, F the total number of magnetic lines of force cut, Z the number of conductors in series and N the number of revolutions made per minute by each conductor, the value of E may be determined by the following formula:

$$F\ Z\ N \div (100{,}000{,}000 \times 60)$$

(To be continued)

Direct Current Motor Field

Connections of a Direct Current Motor Field With Interpoles and Compensating Winding

DIRECT-CURRENT machines are more apt to give trouble than alternating-current machines due to the fact that there are more parts to the d. c. machine than to the a. c.

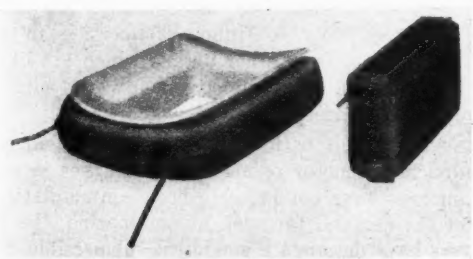

FIG. 2. MAIN OR SHUNT FIELD COILS AND INTERPOLE PIECE

The field structure of the G. E. Type R. F. adjustable speed motor looks rather complicated for the power plant man, as it has interpoles and is entirely different in construction from the ordinary shunt motor. Figure 1 shows the magnet frame construction and arrangement of pole pieces.

If for any reason, any of the field windings must be taken out and repaired, the compensating coils must be taken out first, then the interpoles or the main field poles can be taken out. In rewinding the field coils, care must be exercised to make them as neat as possible

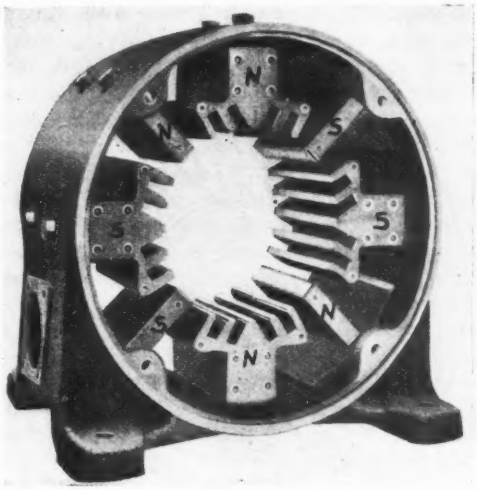

FIG. 1. MAGNET FRAME STRUCTURE AND ARRANGEMENT OF POLE PIECES

and to bring out the leads in the proper places so as to make all connections on one side of the field structure. The commutating coils are usually wound with heavy wire, or ribbon on a copper box that fits over the pole piece. The leads are brought out top and bottom on opposite sides of the same end of the coil. It is best

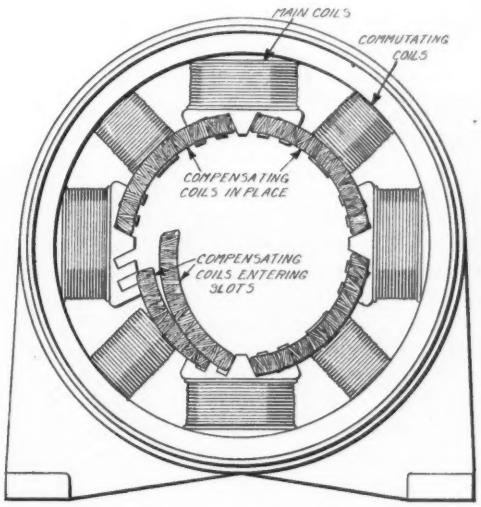

FIG. 3. COMPENSATING COIL INSERTION AFTER ALL OTHER COILS ARE PUT IN PLACE

to start winding all coils on the same side and finish the same way. The form for winding the interpoles is made up in two pieces as shown in Fig. 5, so that the form can be driven out without disturbing the windings. The shunt or main field coils are wound on aluminum spools and must be made to fit as neatly as possible.

Compensating coils are made on the order of armature coils; they must be made the right size, otherwise it will be found difficult to place them in the slots. When all the coils are made, the interpoles are the first ones to be put back in place; next come the main field coils and then the compensating coils; care being exercised to place the compensating coils with winding in

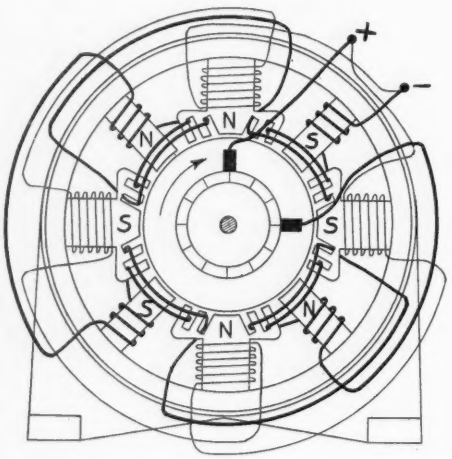

FIG. 4. ALTERNATING CONNECTIONS OF INTERPOLE AND COMPENSATING COILS, POLARITY OF INTERPOLES AND COMPENSATING COILS IN RELATION TO ROTATION AND MAIN FIELD, CONNECTIONS OF MOTOR FIELD COMPLETE

the same direction as the interpoles. Figure 3 shows a compensating coil in progress of insertion. Figure 2 shows one of the main field or shunt coils in aluminum spool and one interpole coil completed with its pole piece.

In connecting up, the connections of the interpoles and compensating coils are formed alternately as shown

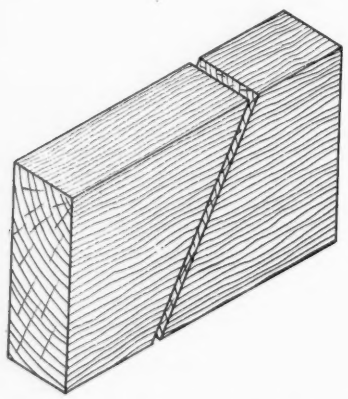

FIG. 5. FORM FOR WINDING INTERPOLE COILS

in Fig. 4. These are connected in series with the armature. The main field poles are connected so as to form north and south poles, meaning, that if pole No. 1 is north, the next one should be south, etc. The relation of polarity between the main poles and the interpoles and compensating coils, depends on the direction of rotation. If the motor runs clockwise facing commutator, the polarity of the interpole and compensating winding should be the same as that of the main pole directly back of it as illustrated in Fig. 4, which also shows the field windings complete, of a motor with compensating coils and interpoles.

Submersible Motors

IT can hardly be doubted but that the raising of ships sunk during the war, and not merely the salvage by divers of valuable items of cargo, will constitute a profitable field of activity, and that many attempts will be made to put into service ships now lying on the ocean bed. There are two highly important factors which enter into the general project of raising a shipwreck, and modern developments should render success much more likely in the future than it has been in the past. The first of these factors is the diver, and in this connection it may be remarked that such great improvements have recently been made in diving apparatus that it is now possible for a diver to operate for a limited time at as great a depth as 300 ft. below the surface of the water. The other factor is the pumping apparatus. It cannot be denied that most of the modern salvage exploits have owed much of their success to the state of perfection to which pumping appliances have been brought during the past decade or so, and one of the greatest of these advances is the application of electricity to the driving of submerged electric motors for driving pumps or for operating portable drills and other tools under water.

For many years past, efforts have been made to enclose motors in different types of casings, so as to make them perfectly water tight and at the same time air tight, but these efforts have not been successful owing to the fact that the heat generated in the motor has tended to destroy the insulation of the windings. An electric motor has now been produced that can be satisfactorily worked under water, even after having been flooded with water for any length of time; in fact, the action of the water is beneficial rather than otherwise, since it is used to keep the motor cool and to increase its capacity. These motors are made in England, and by a new process of insulation the windings are made to withstand completely continuous immersion in water. There are no glands or other details which are likely to give trouble, and the motor starts while submerged without the slightest hitch.

In combination with a suitable centrifugal pump, the submersible motor opens up possibilities in salvage work such as have not hitherto been contemplated, and to meet the demand for such a combination, the manufacturers have designed a combined submersible electric motor and centrifugal pump the only moving part of which is a shaft carrying the armature of the motor and the impeller of the pump. The whole arrangement is very compact and can be readily lowered down to any part of a submerged vessel, placed in position by a diver and worked from the generators on the salvage vessel whether alongside or from any distance away, the electric current being supplied through a flexible cable. In many cases it is only necessary to suspend the pumps

from the salvage vessel's derricks and lower into the water without coupling up any suction pipes. Pumping can be immediately commenced after the length of delivery hose is attached, the whole operation being carried out very quickly. The 4-in. standard combined motor and centrifugal pump is capable of delivering 100 tons of water per hour against a manometric head of 75 ft.

The enormous increase in the size of the modern liner has placed it beyond the capabilities of the lift of the ordinary portable steam or other pumping machinery. Taking as an example the case of a large vessel stranded on a rocky coast, exposed to sea and full of water from end to end. It would involve duplicate sets of ordinary pumping plant, with the risk of their being easily damaged on the first approach of bad weather. Submersible motor pumps could be lowered down to any decks below water, placed in position by the diver, and worked from the generators of the salvage steamer. In the event of bad weather coming on, it is only necessary to disconnect the wires, and the pumps, being under water, well down in the hold of the ship, are in comparative safety, and can be started again immediately the weather moderates, by again connecting up the wires.

In cases where it is not possible to obtain a suitable supply of electricity for working the submersible motor pumps a specially enclosed waterproof portable electric generator, driven by paraffin oil engines, for placing on board a wreck is supplied. These machines being of the enclosed ventilated type with two port holes and ignition covers, can be closed up if the weather becomes too bad to continue working the plant, and can then be left on deck until the weather moderates. In addition to working the submersible motor pumps, the portable generator is also used for lighting, thus enabling operations to be carried on night and day; further, it can be used for working any tools, such as drills, etc., driven by submersible motors, which are frequently required during salvage operation.

It is worthy of mention that among the users of these submersible motor electric pumps is the Liverpool Salvage Association.

The submersible motor is, however, capable of being applied to another field of activity, other than that of salvage work, and that is as an aid in the prevention of a ship sinking when from any cause water is rushing into any part of the interior of the vessel. It is now universally recognized that the electric lighting of a vessel in an emergency should not depend upon the supply of steam from the main boilers. Many instances have occurred—especially during the period of the war—where passenger steamers and cargo vessels have received injury resulting in the flooding of the engine room and stokehold, and in consequence the electric lighting has failed. The absence of light has not only proved a serious drawback to the lowering of the boats, but has also created a panic among passengers and crew. These risks are largely eliminated by the provision of an emergency dynamo situated somewhere on the upper deck. Similarly it is of equal importance that the problem of pumping should not depend on the steam from the boilers or on the ordinary engine-room pumps. It is a fact that is not generally remembered that once a compartment of a vessel is filled to the level of the water outside, collision mats or other devices are of no possible good unless the ship pumps can be kept working in order to create a suction. Hence it is advisable to fit electrically-driven pumps, the power for which can be obtained from the emergency dynamo. A submersible motor in combination with a suitable sized centrifugal pump could be placed in every main compartment of the vessel, and then, should an accident lead to the flooding of this compartment, the pump in this compartment could be started at once, although under water. The system adopted on many ships of installing ordinary electric emergency pumps with long suction pipes is easily rendered inoperative through an air leak in the suction pipe, which is liable to occur in any accident, and when such motors are flooded they become useless. The submersible motor pump, being placed at the lowest level, needs no suction piping, as it works submerged advantageously. This is a great improvement on present methods, but there is the much more important item to consider, viz., that if the pumps can be kept working to create a suction, anything in the shape of beds, blankets, oakum, sacks, etc., can be hauled under the ship in the vicinity of the opening, and will find their way into the hole and in all probability stop the leak.

For electric boat hoists, winches, capstans and anchor windlasses, the submersible motor is claimed to give satisfactory results. In many cases the ordinary types of motors have been found very unreliable in their behavior on account of the corrosive influences of the sea air and sea spray, and it must be obvious that a motor which can be employed with reliability under water or exposed to adverse weather conditions is capable of a wide and varied application.

An Outbreak in a Power Plant

REVOLUTIONS being the natural thing in a power plant, and outbreaks being the fashion in industries, it is not surprising to learn of an indignation meeting held in one of our great plants recently.

Some of the Turbines and Dynamos with the Pistons and Rods got together and talked over their grievances. One Dynamo, pointing a foot toward the Flywheel, said: "Why should we all go on getting all hot and working hard to make electricity for the world when that idle Flywheel does nothing but whirl around on his shaft? We, who produce the power, should get all the credit and attention and care. Look at him. He sticks up above everything else. Everybody sees him and talks about him. He takes up room and gets painted and fussed over, but he's absolutely useless."

Then the Turbine joined in with his shrill voice: "You're right, Mr. Dynamo; that Flywheel belongs to the bourgeoisie. He's never made a watt or a horsepower in the 19 yr. he's been in this plant. I've watched him carefully. He never hurries or gets heated. He just goes round and round. He's kept all polished up, and looks dignified, and doesn't work at all; while I'm grinding away night and day, chewing up 150-lb. steam and turning out light and power. It isn't fair that guy should get away with it and ride all day on the shaft that you fellows work to keep turning."

Up spoke the Piston Rod: "You said something,

Brother Turbine. I've had my eye on that fellow too. It's time for a readjustment and a showdown. I'm sick and tired of this deal where some of us do all the work and others have their photographs taken and get talked about. That non-producer ought to be shown up in his true colors. This is a power plant, and those who don't make power haven't any place here. We ought to think this over and have another meeting to do something about it."

The Steampipe broke out with great heat then: "I am with you, boys. That Flywheel does nothing but sponge on us who do the real work. He never gets sweaty or dirty. He ought to lose his privileges and be thrown out in the scrap pile, where all non-producers belong. He's got iron enough to make a 10-in. pipe a mile long, and it's a sin to have all that idle metal going on in a continuous joy ride without helping us to make power. Power making is a great and important work for the world and every fellow who's in a plant ought to have to be in on the rough grind of making it. Anybody who knows anything about economics or ethics or sociology or socialism can see that a fellow who uses up a lot of space and oil and pressure that we need is a waster. He's a robber; that's what he is, and the day of the idle plutocrat is going to close. We fellows create all the power in this plant, and we should realize it, and not let ourselves be exploited and our means of livelihood stolen by an idler who does nothing. Let's stand firm and protect our interests. I'm tired of carrying steam just to help that great bunch of iron roll around days and nights, and no good to anybody. Here I carry steam 24 hr. a day with never a chance to cool off or rest; and what does he do? Sleeps half the time and joy rides the rest. I'm sick of it. Let's put him out."

"Good for you," spoke up a boiler. "I've been here 26 yr. and I agree. It's about time we had a little democracy and recognition of real merit in this power plant. I've been here longer than he has. And look how I've strained my sides slaving just to show him a good time. I could have rested a lot of times only I had to stay at work just to keep him going. He robs me of a big percentage of what I produce, so I have to work a lot harder to get along. We real workers should wake up. This plant should prove its sincerity and desire for democracy and liberty. We must oust this non-producer, so we can come into our own. Why don't we boycott that Flywheel and refuse to work for him any longer. He stays in a nice, clean, cool room, while I sweat in coal and ashes all day here where there's no sunlight or air, and where it's always hot. He gets all the comfort, and I get all the drudgery."

So the turbine and dynamo and piston rod and steam pipe and boiler decided to organize and talked about a name. They couldn't agree so they adjourned for a later meeting.

By that time their ideas had grown, and they decided to start a movement to make war on all the flywheels of the world. And they organized the "International Power Producers Soviet." They chose red as their emblem and "Down with all idlers" as their battle cry.

They decided to hold a parade to arouse the other plants; but just as they were starting out, a steady voice spoke up from behind the engine. "Boys, wait a minute. I want to talk to you." It was the governor speaking, and the "reds" stopped to listen, for they had always had some respect for him. They had heard that if he quit, the whole plant would likely be wrecked and they would all be out of a job for good. So they waited to hear him.

He went on: "Go easy, boys. Don't forget there are outlaws known as 'dead center' and 'sudden peaks' that can break in here and make tremendous trouble. It's Flywheel who keeps them in order. If it wasn't for him, 'dead center' would hold us up so we couldn't start up; and if Flywheel wasn't on guard 'sudden peaks' would break in with his gang of heavy loads and we couldn't withstand him. Then we'd lose our jobs, for our outside customers would leave us, and there wouldn't be any power plant in operation."

A pump who had not been heard from before spoke up. "I don't see why we should pay much attention to what Governor says. I've run for 18 yr. without a governor, and I've pumped 250,000,000 gal. of water. I'm wise to what that party wants. He knows that he doesn't produce any power either, and he's afraid that, if we unite and organize, we'll throw him out too. He's just one of the followers of the 'plutocrats,' and he gets paid by them. He's one of their apologists and talks for them to save his own job. What does he know about the jobs of us workers? Did he ever make a pound of steam or pump a gallon of water? No! Did he ever make a single horsepower? Not an ounce of power did he ever make. He never burned any coal. He never made a watt. He never boiled any water. He never carried any steam. He's never done any real work. He's an ally of Flywheel. He's in the class with the idlers, and we should put him out and come into our own. I've been down in the dark corner long enough. I demand a place in the sun."

In reply Governor said: "You may all do as you please. If you throw out either Flywheel or me, you'll all soon be out of a job and starving. But maybe you'll have to before you learn the lesson."

Then everybody joined in at once. Some wanted to consider what Governor said, and began to call themselves conservatives. Others joined with Steam Pump and called themselves Radicals. They were for throwing out all Valves and Meters that might in any way control the operation of the plant.

And so the argument raged. Meantime Flywheel and Governor went on about their tasks working with the Conservatives and trying to keep things going so that the Radicals would not wreck the plant and throw everybody out of a job.

That's where matters stood at the last report.

But isn't it fortunate there are Conservatives who keep on working so that there is somebody to feed the Radicals, who are too busy arguing to work? That is, all but the wives of the Radicals, who keep the pot boiling while their husbands teach the mysteries of Bolsheviki economics to the masses.

AMERICAN BLOWER CO., of Detroit, Mich., has purchased a tract of 20 acres in the northeastern section of the city, and is arranging for the construction of a new $750,000 plant there.

Oxy-Acetylene Welding---III*

HINTS FOR BEGINNERS AND POINTERS ON POWER PLANT REPAIR JOBS

IN HEAVY metal, weld from left to right for the following reasons: (1) Heat is conserved in a greater degree than in the possibly more common, right to left method. (2) The adding metal is less liable to bridge over the bottom of the V and therefore a better penetration is secured. (3) The weld can be carried out progressively as the relative angle of the torch with the face of the metal will permit building on adding material without stopping to reheat. (4) The flame covers the face of the weld, assuring a continuous molten state but protecting it from the oxidizing effect of the air.

Keep the pool as large as possible but do not allow it to spread along the groove without having the metal thoroughly fused. Complete the weld as you go. Do not partly fill the groove, even for a short distance, and then go back over it a second time, as each additional heating deteriorates the metal.

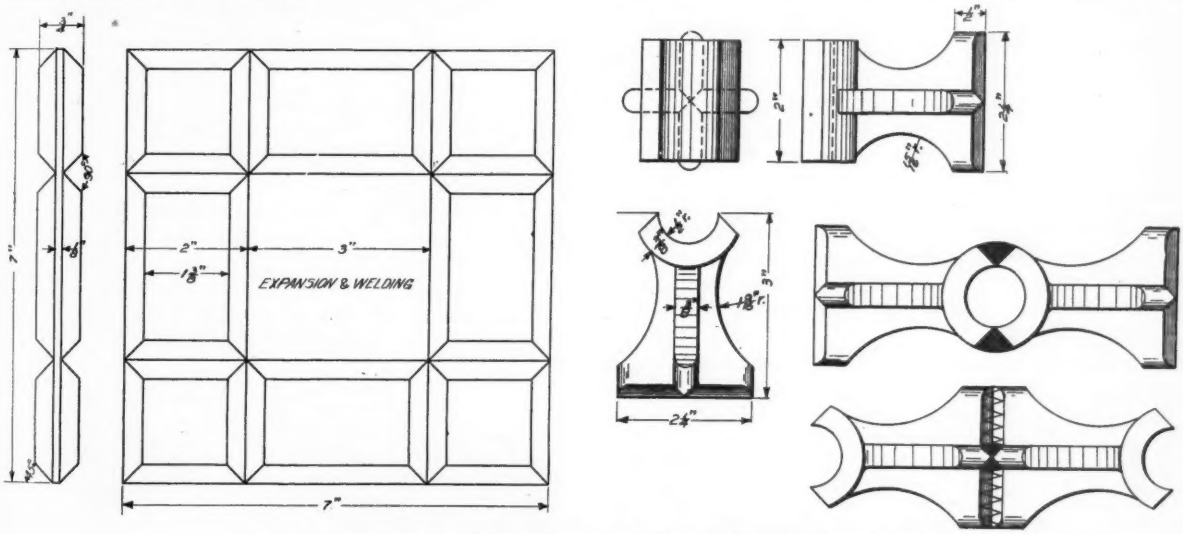

FIG. 1. CAST IRON EXPANSION AND WELDING FOR SEVERAL BREAKS

Heat each side equally. Have both sides in a fused condition so that the adding material will thoroughly unite with the stock. If one side is hotter than the other it is liable to get union on one side and adhesion on the other.

From 90 to 95 per cent of defective welds on heavy metal are due to lack of heat, causing adhesion instead of fusion. The adding metal should be slightly higher in the center and blend out at each side to the thickness of the plate.

For a continuous weld, unless absolutely necessary, do not take the torch away from the weld till the job is finished. If you want to bend your rod keep the torch playing on the weld and slide the rod into the flame till hot, then bend without moving the torch from the work.

In placing the pieces for welding have the left ends about 1/16 in. apart and the other ends about 3/16 in. apart, if the weld is about 6 in. long. Long welds are to be opened in proportion to the length. As the metal contracts on cooling it will draw the pieces together.

In practice, long welds must be made by continuous operation, and it is often necessary to change operators in doing heavy work.

MANIFOLDING OF OXYGEN AND ACETYLENE TANKS

LARGE welds and heavy cutting require large quantities of oxygen. Several tanks may be connected as a series, possibly a Y will be used and two sets of tanks arranged so that one set may be used till empty, then shut off and the other turned on. Or manifolds can be so made that a helper may remove one set of empty tanks and replace them with a full set without stopping the welding.

As the tank valve stems are not provided with a stuffing box it is necessary to back the valve out with sufficient force to compress the washer around the stem to prevent loss of oxygen. If not done this will be a source of considerable loss.

Acetylene tanks should not be manifold without a regulator on each tank to reduce the pressure. In this way no appreciable volume of acetylene is under high pressure. (Acetylene above 20 lb. pressure per square inch is considered dangerous.) This method does not conflict with the rules of the underwriters.

WELDING DISSIMILAR THICKNESS

HEAVY stock requires great heat; hence we must have a tip large enough to give the necessary heat, but this is too large for the thin piece unless used with care. Judgment and skill are required to bring both pieces to the proper heat at the same time.

EXPANSION AND CONTRACTION

OVERCOMING the effects of expansion and contrac-

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tion calls for thought on the part of the operator. As an example of expansion, take a rectangular casting such as shown in Fig. 1. If we heat one side, the expansion will probably break the piece at the other side. Now, we may weld this break, and as it cools the casting will probably break somewhere on the opposite side.

To avoid this trouble it is necessary to preheat the side opposite the break, make the weld, and allow the whole to cool down together.

The effect of expansion and contraction may often be overcome by mechanical means. Before welding, the parts may sometimes be sprung apart by a jack. After welding, the pressure is removed and the contraction of the cooling weld will relieve the strain.

FIG. 2. GOOD AND BAD CYLINDER JOINTS

To help determine where to preheat, imagine a wedge driven in at the break. A wedge driven in at this point would cause strain along the opposite side, indicating where the preheating is needed.

To be able to judge the effect of expansion and contraction and provide for it, requires judgment and experience. Preheating of castings is often best done in temporary furnaces, using charcoal or coal as fuel; gas or oil torches are often effective, and such preheating will often materially reduce the gas consumption. After preheating, cover the casting with asbestos paper or other insulation to prevent rapid cooling and also to protect the welder.

All brittle castings that are liable to have had strains

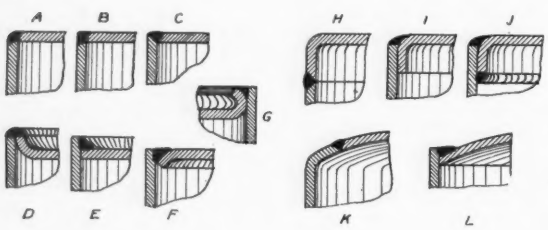


FIG. 3. WELDING HEADS INTO TANKS

produced by contraction should be tested by jarring judiciously with a hammer so that excessive strains may relieve themselves by cracking rather than risk a break after the part is put in service.

Preheating may be done with the torch if the parts are small, or a forge fire is often convenient.

The following illustrations and descriptions will give those with limited experience an idea of how to handle jobs of various kinds.

PREPARING THE WELD

"A" FIG. 5 SHOWS a method of preparing cast iron by making a number of cuts with a hack-saw and then breaking away the small sections thus produced by driving them sidewise. This makes it possible to leave alinement edges on each end and the bottom which assures the correct alinement of the piece. These sections, thus left, being afterwards welded from the sides and back. The saw cuts are made at 45 deg. with the surface to be welded. B shows the piece thus prepared, C an oval section prepared in the same manner in which three alinement points are left, this being valuable on certain classes of work that cannot otherwise be readily lined up.

WELDING IN A TANK

A, FIG. 4, shows a partition flanged and inserted in the inside with a weld made around the flange. This

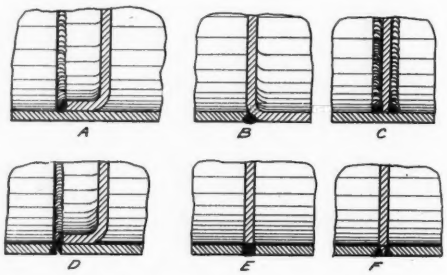


FIG. 4. WELDING A PARTITION IN A TANK

is a difficult thing to do successfully, as the shell of the tank expands away from the flange by the heat of welding. It is necessary to tack it closely before proceeding to weld.

B shows the partition as a solid drawn head or possibly a flanged head welded to the shell, the other part of the tank being formed by welding another shell in the corner produced by the knuckle of the head.

D shows the welding of a flanged head to the shell of one part of the tank by an edge weld, the other part

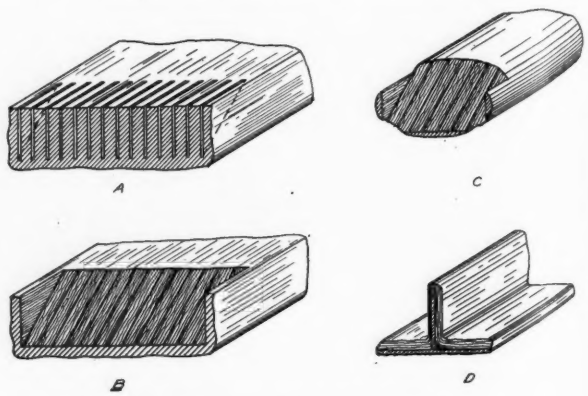


FIG. 5. PREPARING THE WELD

of the shell afterwards being lined up and a butt weld made. The dissimilar thickness of the metal makes such a weld difficult and there is also a great possibility of the first weld opening up due to internal strains while the second one is being made. It would be better to press the head in a short distance and weld as at A, leaving sufficient of the shell projecting so as to make a straight butt weld to the other part of the shell, this probably making the best form of joint.

F shows a partition between two shells, but with the partition brought to the outside of the shell and a dis-

tinct weld made on each side. This is fairly satisfactory provided the plate is reasonably thick.

Figure 3. If a flat or dished head is welded to the shell by a corner weld, as at A, it is unsatisfactory where strength or resistance to flexure is required as a greater flexure occurs at such a corner than at any other part of the tank. B shows the same condition but with the weld built out to a square corner, which is expensive. C has the square corner produced by preparing the plate and making the weld on the inner edge.

A flanged head, as at D, forced into the shell concave side out and joined by an edge weld, is not satisfactory, as an edge weld has an uncertain depth and cannot be depended on. It is much better to force the head in for half an inch and weld in the angle formed by the shell and flange somewhat as in E.

F is a flat head with a 45 deg. flange set inside and the groove filled up, while G has the flange turned to 135 deg.

At H a flanged head is shown welded to the shell by a butt seam of the usual type, making probably the best type of joint but requiring close accuracy in the size of the shell and head flange.

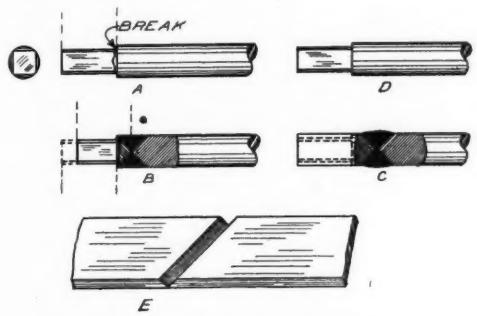


FIG. 6. WELDING SHAFTING

I, a flanged head inserted inside the shell and a corner weld made, gives a continuous radius with the knuckle, which is the most common type. Where possible, J, with the inside flange welded, makes the best job, but can be done only on tanks of large size having manholes. Frequently on light tanks the head will be forced in flush with the shell and the edge of the shell hammered, rolled, or spun over the knuckle, thus relieving the weld of all strain which then serves only to make the joint tight.

K has the shell flanged to form a part of the head, making the weld at the point of least flexure, while L is a dished convex head inserted into the shell a sufficient distance to allow for a substantial weld being made in the corner.

Note.—Any of these joints can be made with convex or concave dished heads instead of flat.

Shafting Repairs

Figure 6 A shows a shaft having a square on the end as often used in machinery. Owing to the change in section fractures frequently occur, as shown, at the corner. It is inadvisable to make a weld at this, the weakest point in the shaft, but it is better where possible to shorten up the larger diameter, thus shortening the square section, make the weld and build up the shoulder as required. In this way utilize the broken parts so that with care they can be used again with little machining as at B. If this is not possible, it is necessary to throw the broken end away, replace it with a round piece of a length sufficient to make the weld in the large section. This must then be machined to meet the requirements as is shown at C and D.

E shows the advisability of making a diagonal weld everywhere where possible so as to increase the length of the weld and therefore its proportionate strength.

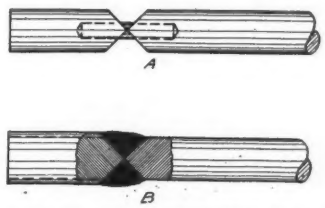


FIG. 7. WELDING THE SHORT END OF A SHAFT

Where the short end is required to be welded to a shaft, it is exceedingly difficult to line up the short end unless it is doweled as shown at A, Fig. 7, and there is then no assurance that it will be in line though it must be concentric, and it is better to weld a larger section as at "B" and machine to the required size.

Welding Gear Teeth

There are two methods of welding gear teeth, depending upon the size of the teeth and general conditions. It is impossible to fill in the individual tooth broken out as at A, Fig. 8, as the heat cannot be localized so as not to damage the adjacent teeth and there

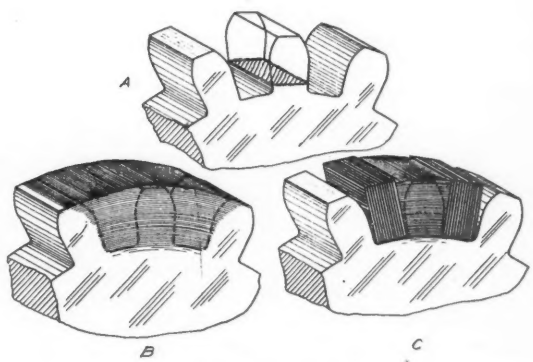


FIG. 8. WELDING GEAR TEETH

is insufficient space to make a sound weld. It is better to fill in between the adjacent teeth as shown at B. If, however, the teeth are of sufficient size, the adjacent teeth may be protected by carbon blocks as shown at C, enabling the tooth to be chipped, cut with a hack saw, or filed to shape. In welding a tooth in this way, the blocks should be sufficiently far apart to allow of getting the radius at the root of the tooth in solid welded metal, otherwise the tooth will be weak and readily break. This condition generally prevents the possibility of making the weld to approximate the correct shape of the tooth.

pipe, and cut the branch more or less accurately to form a slot as shown at A, Fig. 12. It can be seen that it is frequently impossible to insure the weld penetrating any depth. The strength almost entirely depends upon the metal added on the surface to form a fillet.

Welding Nozzles to Flat Surfaces

Difficulty in making a satisfactory weld of this type is due to the 45 deg. groove that will be formed by ordinary preparation, a surface corner weld being undesirable. In the methods shown, the end of the nozzle is flared so as to increase the extent of the groove and the welds made by different methods as shown in A, B, C, Fig. 9.

Cylinders

In welding a sheet into the form of a cylinder there is trouble in keeping the edges of the plates in line. The joint should be open slightly at the end where the weld is started, the other end being open a greater dis-

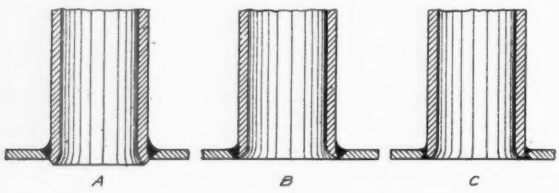


FIG. 9. METHODS OF WELDING NOZZLES TO FLAT SURFACES

tance to allow for contraction, to an amount about 2½ per cent of the length of the joint, the exact amount depending on the skill and speed of the welder. A seam weld should never be started with the metal in contact.

A pressure container having a section that is not a true cylinder tends to assume a cylindrical form under pressure. If of a form shown in A, Fig. 2, it will tend to assume under pressure a section like B. If the edges

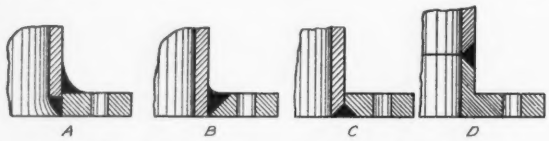


FIG. 10. THE WELDING OF FLANGES TO PIPE

of the plate are as shown at C, E, or F, Fig. 2, they will tend to take a cylindrical form, and in doing so, produce a bending strain which, in addition to tension in the plate, will often cause failure. The edges should meet as shown at D.

Types of Longitudinally Welded Seams for Pressure Containers

The longitudinal seam of a pressure container is most important, owing to the fact that it has to stand twice the strain of the girth seam. It is, therefore, very necessary that a joint of this type should have careful consideration, as the failure of a pressure container will frequently result in loss of life. It is usual, on thin metal, not to prepare the edge. It is not desirable, however, to butt the edge as at A, Fig. 11, but leave the metal open as at B, as this will give greater assurance of a through weld. The ordinary method of making a weld where preparing is necessary is shown at C. It is possible, under some circumstances, to use the joint shown at D; but it is not to be recommended, as naturally a tearing action takes place and a weld of this type seldom has any depth. It is, however, used extensively on electric transformer casings, as, due to the flexibility of the corrugations, very little strain can be thrown on the weld. It is undesirable to load or build up a weld, as shown at E, so as to offset any incompleteness of the weld, as eccentric loading will produce a tearing effect, as shown at F, so that the effect of the reinforcement is negligible. This can be offset, however, to some extent by assuring that the weld is through by welding on the inside, as at G, if dimensions permit.

It is better, however, to make a weld as shown at H, the preparation being obtained by bending the plate ends to an angle of 45 deg., forming a groove, provided the thickness will allow, the depth of the groove thus formed being sufficient to insure strength with the welding skill available. In this way sufficient thickness of weld is produced to carry the direct load and also to stiffen up the joint so that it is not possible for flexure to take place in it. If the plates are too thick to bend,

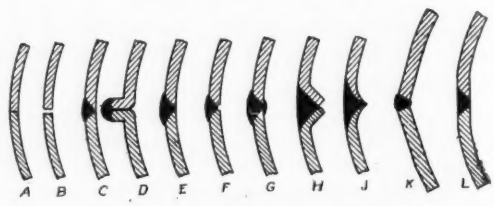


FIG. 11. TYPES OF LONGITUDINALLY WELDED SEAMS FOR PRESSURE CONTAINERS

the preparation can be carried out as shown at J, the edges being beveled to 60 deg., leaving 30 deg. and the points "fullered" to the required shape. It is very essential in a pressure container that it should be truly cylindrical, as pressure exerted on the inside will tend to bend it to this shape, if not so already. The ends of the plate are frequently left flat, as at K, forming a peaked joint, in which it can be readily seen there will be considerable bending effect, produced by the varying pressures to which the container will be subjected, thus jeopardizing the weld. Though it may be strong enough to withstand the hydraulic test of several times the working pressure, the continual flexure produced will eventually result in failure. This type of joint is frequently produced by not separating the edges of a plate at an angle lengthwise when welding. The effect of the excessive shrinkage strains thus produced causes the plates to assume this shape. The plate shown at L is generally produced by unsatisfactory rolls or insufficient operation in rolling and should always be avoided on pressure work for the same reasons as given for K.

Nozzles or Branches on Pipe

As there is excessive strain at the joint where a nozzle or branch is welded to a pipe, due to expansion and contraction as well as other causes, it is desirable, particularly if it is to be used for steam, to make a substantial joint. The usual method is to cut a hole in the

It is much better to flange the branch as shown at B or to butt as shown at C, the former being preferable as it spreads the load over a large area.

Patches in Plates

Frequently it is impossible to weld patches in a plate without excessive internal strains, due to the rigidity of the plate in which the patch is welded. It is then desirable to make a patch of such a form that it will spring when subjected to excessive strain and thus minimize the effect of the contraction. This can be done by dishing the plates by any of the methods as shown at A, B, and C, Fig. 13.

Welding Flanges to Pipe

A, Fig. 10, shows the most common method of welding a flat flange to a pipe, by filling in the inside corner produced by inserting the pipe only partly through the thickness of the flange.

Sometimes this is reinforced by an outside corner

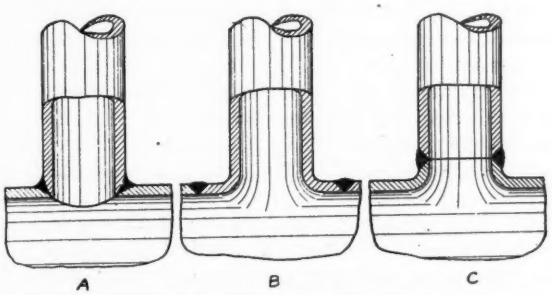


Fig. 12. Types of Nozzles or Branches on Pipes

weld, which cannot be considered a satisfactory job and is also expensive. In B, the flange is beveled from the outside and the weld is made as complete as possible. This, however, is difficult, due to the angle of preparation being only 45 deg.

In C, the end of the pipe is beveled to 45 deg. with the hole in the flange forming a 90-deg. groove, which allows the weld to penetrate only half-way through the flange, giving insufficient strength except for the lightest uses. D represents the best type of a weld for all purposes. The flange having a boss formed up on one side the same thickness as the pipe, making the weld the same as welding two lengths of pipe. The length of the boss must be equal to two thicknesses so that the thicker metal of the flange will not interfere with the heat balance in the weld. Frequently welds are made with the boss projecting not more than one thickness, which are machined down from the solid metal.

Carbon Burning

The oxygen torch gives a quick method of freeing a gasoline engine cylinder from carbon, which may collect in nodules on the pistons or in any part of the combustion chamber. The trouble caused by carbon is from pre-ignition. The nodules of carbon become red hot, and this heat, added to that of compression, often fires the charge before the proper time, causing severe knocking, and loss of power due to the explosion occurring too early in the stroke.

This carbon can be cleaned out quickly by the oxygen jet.

Before attempting to burn out the carbon in a cylinder, be sure the gasoline is turned off at the tank and that the carburetor and gasoline pipes are drained. The piston must be at the head end of its compression stroke and both engine valves must be closed. This point can be found by opening the pet cock and turning the engine over by hand till the end of the compression stroke is reached. Then remove a spark plug, or better, a larger plug, and insert a small bit of oily waste.

The oxygen burner is a piece of soft copper tube fitted with a valve that may be attached to the oxygen hose.

(If there is plenty of time it is good practice to put about one-half a teacup of kerosene in each cylinder and let it stand overnight. This will soak into the hard carbon and make it easier to burn.)

The oily waste is lighted and the oxygen jet introduced. The jet should be moved around so as to reach all parts of the combustion chamber, as the carbon will not burn unless the oxygen jet comes in contact with it.

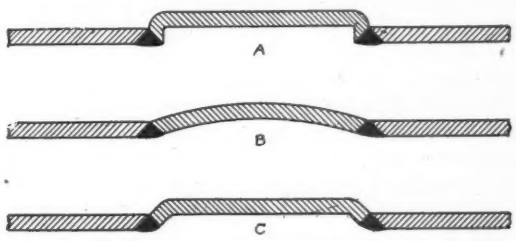


Fig. 13. Welding Patches into Plates

After the first treatment, it is a good plan to spray the inside of the combustion chamber with a mixture of lubricating oil and kerosene in the ratio of 4 to 1 and again burn out with the oxygen jet. In this way the cylinder may be very thoroughly cleaned.

Treat each cylinder as above, being sure that the piston of the cylinder being treated is at the head end and both valves closed before starting to burn out the carbon.

Call has been issued by James A. Farrell, Chairman of the National Foreign Trade Council, for the sixth convention, to be held in the Congress Hotel, Chicago, Thursday, Friday and Saturday, April 24 to 26.

Mr. Farrell says the abrupt termination of the war in Europe has brought the United States suddenly face to face with questions of grave concern to American foreign trade and industry. We must rely, as never before, on foreign trade for the full employment of labor, to prevent disturbance of domestic conditions and to insure the retention and operation of our new merchant vessels under the American flag.

All Americans engaged in or wishing to enter overseas commerce are invited to participate in the convention, which will be devoted in part to the presentation of papers by men who are directing the chief industries of the nation, and in part to discussion of specific problems dealing with foreign trade. Practical information for present needs will be the dominant note of the convention, which will be operated partly in general sessions and partly in groups for discussion of specific questions.

Power Conditions in Europe

DEVELOPMENTS PROPOSED IN SWEDEN AND OUTLOOK FOR THE FUTURE. DATA SUPPLIED BY THE ROYAL CONSULATE OF SWEDEN

DIFFICULTIES CAUSED by the world-war on a larger or smaller scale have further increased during the past year. Not least has electrical industry been burdened, especially by shortage of raw materials. There has been no import whatever of copper during the year, and the home supplies have commanded steadily increasing prices.

MATERIALS

AT THE BEGINNING of the year, the quotation for finished material averaged 55 cents a lb.; at its close, it was about 97.5 cents. Iron, owing to the increased prices of coal, has increased from 3 cents in 1914 to about 10.3 cents a lb. (cast). Steel, which before the war brought 4.85 cents a lb., has gone up as high as 30.3 cents. The scarcity of manganese has thrown substantial difficulties in the way of the supply of axle-steel. Tin and antimony have been very difficult to get, while there has been a comparatively good supply of zinc and lead.

Supplies of mica have been very short, and quotations have varied with demand and supply from $1.21 to $18.20 per lb. Cotton insulating material has been largely replaced by paper.

Finally a shortage of oil has made itself felt in the manufacture of transformers. The price of common transformer-oil has risen from 4.85 cents before the war to 85 cents, and in individual cases substantially higher prices have been paid. The shortage of oil has brought about limitations in the use of oil-cooled transformers for small sizes and low tension. During the year much work has been expended on the production of native oil from tar-products. How far these products can be made to satisfy the earlier normal requirements for transformer oils will probably be shown in the immediate future.

If to the increased prices of materials be added railway freights, which have been raised more than 150 per cent, and wages, which have been doubled in consequence of the general high prices, it is easy to understand how prices of electrical manufactures have attained a level which, according to earlier notions, is absolutely abnormal. On the average, the increase in prices of electrical machinery since the time before the war may be estimated at 200 per cent.

In spite of all this, the electrical industry down to the end of the year has had a very animated market. This has been helped partly by the boom from 1916 in certain important and wealthy industries, and partly by the demand, which has increased with the scarcity of fuel, for electrical energy from our waterfalls, both for power and for light. The output figures for our larger electrical machinery firms have therefore beaten all earlier records in 1917. First comes Allmanna Svenska Elektriska Aktiebolaget of Wasteras with about 24,000 machines with a total of 500,000 kw. Luth & Rosens Elektriska Aktiebolag, Stockholm, has manufactured about 4000 machines and transformers; and Elektriska Aktiebolaget Eck 6000 machines, with a total of about 70,000 kw. Among other firms in the electrical line may be mentioned Max Sieverts Fabriks A-B, which manufactures electrical cables. The sale for 1917 amounted to $4,930,000, as compared with $3,315,000 in the previous year. A new cable works has been erected at Klosteras.

STATE POWER STATIONS

IF WE turn from manufacturing to the power industry, we come first of all to the State's managing department in this line Kungl. Vattenfallsstyrelsen. This department's electrotechnical bureau has kindly supplied us with the following information concerning the work of the Waterfalls Council. The load of the power stations has risen considerably since the beginning of the year. The maximum load of the Trollhattan power station has reached 66,000 kw., which means that all the eight machine units have had very nearly full load. The quantity of energy supplied has reached about 416 million kw.-hr.

The maximum load of the Alvkarleby power station has reached 44,000 kw., corresponding to about 90 per cent of the full load of all the machine units. The energy generated during the year has reached about 187 million kw.-hr.

At the Porjus power station the maximum load in the three-phase department has reached about 9400 kw., and the corresponding production of energy about 37 million kw.-hr. The maximum load of the one-phase lines reached 11,400 kw., and the corresponding production about 10 million kw.-hr.

If we put all these together, therefore, the maximum load on the State power stations has reached about 130,000 kw., and the production of energy about 650 million kw.-hr. The corresponding figures for 1916 were about 115,000 kw. and 515 million kw.-hr. respectively. The increase has consequently been 13 per cent and 26 per cent respectively.

ELECTRIC RAILWAY PLANTS

WITH regard to the electrification work of the State Railway Council, it must be mentioned that the work carried on since 1911 on the electrification of the Lappland railway was finally completed during the year. This important installation has proved to fulfill all expectations from both a technical and an economic point of view. In the course of the year four new electrical iron-ore locomotives, of practically the same build as the older ones, have started running, supplied by Allmanna Svenska Aktiebolaget and the Flun wagon works.

For the commencement of the electrification of the Kiruna-Svarton section the Riksdag has made a grant of $936,000. The enormously increased prices of materials, however, will probably prevent any energetic prosecution of this work; and indeed railway electrification in general, despite the great interest in it shown in many quarters, has been rendered highly difficult in the present state of things.

The economic importance of railway electrification, however, cannot be more clearly demonstrated than by

the fact that the additional cost of the fuel required by the State Railways in the present year, compared with the prices of 1913, represents an amount of the same magnitude as was calculated, some years before the war, to be needed for the electrification for the entire State Railway system. When more favorable conditions return, therefore, we may hope for great expansion of this department.

Private Plants

Among private power stations, we need here mention only some of the largest, which have furnished statistical data:

Hemsjo Kraftaktiebolag has supplied during the year 28.7 million kw.-hr., and the maximum load of the year is 7500 kw. During the year the company has obtained a considerable addition to its capacity through the new power station at Hemsjo Nedre, which is for the present equipped with one unit, corresponding to the supply of water during a period of low water and in the first place designed to increase the supply of energy during the summer and autumn, and to a corresponding degree save the fuel which is so costly at the present time.

The company supplies power to industry and agriculture in Smaland and the adjoining parts of Blekinge and Skane.

For 1918 the electrification of the southern part of the county of Kalmar is being planned in connection with Finsjo Kraftaktiebolag. In 1917 the country districts around Kalmar were surveyed, but no equipment could be laid down because the farmers hesitated to incur the high costs of installation. This year, however, the question has been taken up again, not only for the southern mainland portion of the country, but also for Oland. It is not impossible that, with the expected aid of the State authorities, a high-pressure cable to Oland may prove itself economically practicable, especially as the cement-works in Degerhamn use a considerable amount of power, which in an extremely advantageous manner can supplement the load-curve on agriculture, handicraft and minor industries.

Kraftaktiebolaget Gullspang-Munkfors has supplied during the year 67 million kw.-hr., and the maximum load has been 12,700 kw. A lively interest has been shown within the distributing area of the company for the electrification of the country districts; and a number of distribution associations have come into existence, which have furnished their members with electrical energy. A further number of similar associations have also been projected; and in consequence of this the company's secondary stations have been enlarged, and further extensions are being planned. A reserve station in Lidkoping has been completed during the year for the purpose of connecting with the Trollhattan works.

Yngeredsfors Kraftaktiebolag has particularly suffered during the year from the considerable restrictions in the textile industry, which forms an important part of the load of the works. The number of kilowatt-hours amounted to only 18,000,000, as compared with very nearly 23,000,000 in 1916. Among the larger new customers may be mentioned the Varberg Ironworks, which in the future will probably take large quantities of energy.

An entirely new concern in the power industry, of considerable scope and great interest, has come into existence during the year in Bergslagens Gemensamma Kraftforvaltning, formed as an amalgamation of the co-operative type, the participators in which contribute amounts proportionate to the horsepower of their several establishments. By means of this coupling of the power installations of the Bergslag district proper, there has been gained an increase in the prime power produced of 20 million kw.-hr. per year. By the installation of the necessary steam reserves there can be developed a further amount of 40 million kw.-hr. a year. The combination comprises over 100 power-stations, representing about 85,000 hp. in water and 26,000 hp. in steam.

Already, however, further augmentations of power have been projected, inasmuch as the five great works Forsbacka, Sandviken, Hofors, Avesta and Fagersta as early as the close of 1916, purchased the Krangede Falls in the Indal River, which, after the regulation of the water-level, should be able to yield no less than 120,000 hp.

In connection with the above, on April 4, 1918, the Waterfalls Council submitted to the government a proposal to lay before the Riksdag this year a scheme to grant a further $670,000 to carry out distribution equipment for the power stations of the State. Among the reasons given by the Council is the fact that the influx of applicants for power is so great that the funds that will be available for carrying out distribution equipment during the present year fall far short of the requirements. The Council considers it unavoidably necessary, therefore, that increased grants should be requested for the purpose in hand.

With the equipments that have been carried out during the present year the Waterfalls Council has, roughly speaking, provided for the power-requirements of the larger communities and the greater industries. But at the present time it is largely the smaller consumers that ask for power. Especially has the demand for power for agricultural purposes become so extensive that the Waterfalls Council has so far not considered it possible to satisfy it, due regard being taken to the high cost of the local network and the equipment of consumers. Suitable changes in the system of distribution, however, especially the use of iron instead of copper for the power wires, have, to a certain extent, neutralized the scarcity and the high prices of materials. The price of iron-wire has fallen somewhat of late, and a possibility has offered itself of obtaining oil for transformers.

In addition to all this, the Waterfalls Council considers it desirable during the present year to commence the system for transmitting power from Porjus to Lulea. The transmission of power from Porjus and Harspranget to the coast of Norrbotten should indeed be inaugurated as soon as possible. The general conditions—climate, transport possibilities and the housing question—strongly suggest that large-scale industry in Upper Norrland should, as far as possible, be directed to the coast region.

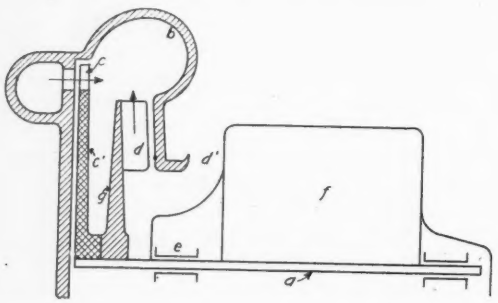
During the latter part of last year the Waterfalls Council concluded a contract with the Norbotten Ironworks Co. for the supply (to begin with) of 10,000 kw. for the manufacture of iron. It is intended that this

amount of power shall be increased to 40,000 kw. The contract is based on the supply of the power at Malmberget; but the company has intimated its desire to locate its ironworks at Lulea, provided that the State is willing to transmit the power there, and has declared its willingness to pay for the increased annual cost caused by the greatly increased distance of transmission. The Waterfalls Council warmly recommends that the power be transmitted as desired. The total cost is estimated at $845,000.—Swedish Exports.

Improvements in Steam or Gas Turbines

By J. H. Blakey

THE OERLICHON CO. has been granted a French patent, No. 485,977, dated Feb. 26, 1918, for improvements in steam or gas turbines. The device is particularly applicable when the turbine is used in direct drive, and more especially when the machine driven is an electric generator, which is more likely than any other machine to be injuriously affected by heating, due to its close proximity to the turbine.



IMPROVEMENTS IN STEAM TURBINES

The arrangement in a simple non-condensing form is shown in the figure, in which a is the shaft of the turbine and of the dynamo. The fixed part, b, of the turbine acts as casing for wheel c', and also surrounds ventilator d, suitably arranged for the cooling of dynamo f, and of bearing e. Air is drawn in along the passage d', after passing over the dynamo, and is then thrown into the compartment b. This arrangement also makes unnecessary the employment of the stuffing box gland, which is generally used near the bearing to insure the tightness of compartment b of the turbine. The same principle lends itself to various forms of application, and in one of them, condensing, the compartment which receives the escape of the wheel c is distinct from the casing b, into which the ventilator drives the warmed air, a diaphragm being interposed between the two parts of the machine. In the figure the two compartments are not separated, but the wheel c' which carries buckets c is distinct from wheel d which carries the vanes of the ventilator. A simpler arrangement still is that in which the ventilator vanes are mounted directly on wheel c' of the turbine.

WHERE THERE is choice of coal to be stored, that having the lowest oxidizing rate should be chosen, if known.

What Congress Provided

THERE WAS passed by congress and approved by the President June 27, 1918, a law generally known as the "Vocational Re-educational Act," and sometimes the "Smith-Sears Act," which provides that any member of the armed forces of the United States government who has been so disabled as to entitle him to receive compensation from the war risk insurance bureau, and "who, after his discharge, in the opinion of the federal board for vocational education is unable to carry on a gainful occupation or resume his former occupation or enter upon some other occupation, or having resumed or entered upon such occupation is unable to continue it successfully, shall be furnished by said board, where vocational re-education is feasible, such course of vocational rehabilitation as the board shall prescribe and provide.

"Every person electing to follow such a course of vocational rehabilitation, while following it, receives monthly compensation not less than $65 per month or equal to the amount of his monthly pay for the last month of his active service, if that was in excess of $65."

The re-education provided is purely voluntary on the part of the man taking it; there is no compulsion. Any man found qualified as entitled to undertake the course is allowed subsistence and all expenses of education such as tuition, books, library and laboratory and other fees. There is no time limit set for the completion of the education. The sole, dominating idea of the government is to make the man efficient in the line which he has elected. When he has completed the course, if it be a wage earning occupation, the placement division of the federal board has found employment for him and he is inducted therein and supervised for a period of practical apprenticeship in order that he may demonstrate beyond doubt that he is able to carry on the work under conditions of active competition with men who have not been injured. When he does so qualify and is accepted as a competent worker and is placed upon the pay roll as such, then his support from the federal board ceases and his pay, of course, begins as a skilled workman. At the same time, his compensation begins from the war risk insurance bureau and this is absolutely unaffected by any amount which he may be able to earn.

The federal board for vocational education at Washington is earnestly endeavoring to get in touch with all war disabled men to discuss their cases with them, and award the special training if it is necessary and the man is qualified.

ENGLAND is undergoing an embarrassing epidemic of railway strikes, and the London Times asks, "Are we having peace or war at home?"

Recently the London District Railway was completely shut down, and although all the tram drivers did not join in the strike, the force at the railway power plant walked out without notice. Supplementing the strike of the subway employes and the locomotive engineers of one of the district steam railroads, this move seriously affected the traffic situation. It indicated the intolerable menace offered to public welfare and orderly government.

Knocking in Gas Engines

Its Causes and Remedies

KNOCK in a gas engine is frequently a warning of approaching breakdown. For this reason, it is generally inadvisable when hearing a knock to allow an engine to continue running longer than absolutely necessary.

Probably in the majority of cases, knocking is the result of lost motion in some part of the engine. For instance, the connecting rod brasses may have become worn, or the flywheel keys may have worked loose, and so on. As a general rule, the first thing the average engineer does when he discovers a knock is to close up the big or the small ends of the connecting rods, or both ends if necessary; in many cases this will cure the trouble.

It will occasionally happen with large engines, however, that after fitting new connecting-rod brasses a new and heavy knock will develop in the engine cylinder. This may usually be accounted for in the following way: The continual motion of the piston to and fro in the cylinder has worn away some of the metal of the liner, leaving a ridge at the part where the first piston ring moves up to each stroke. Since the new brasses are thicker than the old ones, the effect is to cause the piston to move a little further up into the cylinder each stroke, with the result that the first ring strikes against the ridge each stroke, causing a heavy knock. Of course, where the engineer-in-charge has taken precaution to fit liners behind the brasses where wear has taken place so as to maintain the correct centers, the trouble in question is not liable to arise.

To prevent this new knock, it will be necessary to remove the ridge referred to by chipping and filing. If it be impracticable to do this early, the first ring may be removed from the piston until such time as the true remedy can be applied.

Sometimes the piston rings will cause knocking or rattling through being loose, and it is not always an easy matter to trace the knocking caused in this way. When, therefore, a knock cannot be at once located, it is advisable to see if the piston rings are a good fit in their grooves.

Looseness of the flywheel keys is a somewhat common cause of knocking in gas engines. The conditions of working in a gas engine are of course severe, much more so than is the case with a steam engine, and with the increased pressures and speeds, it is no easy matter to get the keys to remain tight for long periods. The slightest amount of slackness is obviously serious as in addition to giving rise to more or less severe knocking, it involves risk of damage to the keys, and fracture of the wheel boss and possibly the crank shaft. Loose keys are always liable to be met with if the wheel boss has been bored slightly too large or at all out of center.

It is not sufficient that the flywheel keys be quite tight; they must be a perfect fit. In numerous instances, the keys have been found as tight as possible, but the flywheel was, nevertheless, slightly loose, and a heavy knock occurred in consequence. An interesting example presented itself when a large gas engine was reported to be knocking, and the owners, who were unable to locate the knock, arranged for a firm specializing in engine repairs to look into the matter. The firm's men commenced their investigations first by removing the connecting rod and piston with the object of closing the brasses, but this was found to have been done already by the owners. The piston rings were next examined for slackness or breakage, but these were found to be in good condition and to fit perfectly. The flywheel key was then examined, but proved to be quite tight. As the cause of the knock could not be located, those concerned decided to give the engine a thorough overhauling. Yet, after this work had been completed, the engine, on being started, knocked as badly as ever. The cause of the trouble was, however, discovered shortly afterward by chance. The engine had been stopped again, and the man in charge of the job happened to place his foot on one of the arms of the flywheel by way of a rest, and in order to think the matter over. While in this position the man felt a distinct knock on the sole of his boot. This gave the clue to the solution of the trouble; obviously there must be some slackness or lost motion in the flywheel. Although the key had previously been found quite tight, a close examination of the key and its keyway were now made, and served to show not only that the key was badly proportioned and badly shaped, but that the keyway had been badly cut, being narrower in the middle than at the ends. In short, only a short length of the key was really effective in securing the wheel to the shaft, and this was the cause of the whole trouble.

It has already been pointed out that the continual motion of the piston to and fro in the cylinder gradually wears away some of the metal of the cylinder liner, leaving a ridge at the end of the travel of the first piston ring. In extreme cases the wear is so pronounced that the piston becomes quite slack in the liner, and this will sometimes prove to be the cause of the knock. Thus, when the explosive mixture is fired, the force of the explosion causes the piston to shake against the internal surface of the liner, and a knock is thus likely to be heard each explosion stroke. A knock of this character can scarcely be regarded as a serious one, since no undue stresses are likely to set up on any of the parts. What is perhaps of more importance than the knock is the loss which will probably occur by leakage of the explosive mixture past the piston. The remedy for the trouble is of course to re-bore the cylinder liner and fit a new piston, or else to fit both a new liner and a new piston.

One cause of knocking in gas engines, but one which is usually easy to discover, is undue clearance between the spindles of the different valves, and the levers which operate the valves. When the valves are properly adjusted for lift, they are first opened gradually by the cams which work the levers, and then more rapidly.

When, however, there is a considerable amount of clearance between the valve spindles and the levers, the latter, instead of coming into contact at a moment when they are moving slowly, only do so when the rate of motion has become comparatively great. The result is that the levers, instead of coming into gradual contact with the spindles, bang against them, thus tending to cause a knock. If now the valves lift easily, the force of the blow is relieved, and the knock will be of little importance; but if, on the other hand, much force is required to lift the valves, the knock is liable to become somewhat severe. In the case of the gas and air valves, comparatively little force is required to open the valves, because each valve opens at the commencement of the suction stroke, when the piston is really reducing the pressure against which the valves have to lift, and so assisting in opening them.

The case is quite different with the exhaust valve. This valve has to open at the end of the explosion stroke, when the pressure in the cylinder is considerable. Since, in addition to this pressure, the pressure of the spring which keeps the valve down on its seat during the admission, compression and explosion stroke has also to be overcome, not to speak of the weight of the valve itself, it is not difficult to understand that the force required to open the valve is considerable. Hence, when there is much clearance between the exhaust valve spindle and lever, the knock resulting may prove to be somewhat serious. The force of the blow is, of course, transmitted to the teeth of the skew wheels which drive the cam shaft, and if these teeth are much worn, as they frequently are in engines which have seen much service, risk of breakage of the teeth is incurred. Knocking of a somewhat similar nature to the above will sometimes occur as the result of undue wear of the rollers against which the cams work, the latter banging against the rollers once each cycle.

Another somewhat common cause of knocking in gas engines is premature firing. Thus, if the charge is fired much before the piston reaches the end of the compression stroke, the general effect is to tend to check suddenly the motion of the piston, so that if there is the slightest lost motion in the moving parts, a more or less severe knock is liable to occur each cycle.

Too early firing may, of course, be caused through improper adjustment of the ignition arrangements; but it will sometimes occur when the adjustment is quite in order. The trouble will then generally be due to the deposit of carbon on the valves, the cylinder end, and on the piston.

When the trouble referred to is experienced, it is therefore well to look for evidences of carbon deposit, and should any be discovered, it should be removed at the earliest opportunity. Satisfactory removal can, as a rule, only by effected after the piston has been withdrawn. It is far from wise merely to loosen the deposit and trust to this being blown out through the exhaust valve. Unless the deposit is positively removed by hand after the piston has been withdrawn, there is every probability that the engine will soon suffer severely from scored piston rings and cylinder walls.

ONE PRECAUTION to prevent accidents is worth a thousand afterthoughts.

What Necessary to Qualify?

NO line of free re-education for disabled soldiers in all the more than 400 at the disposal of the Federal Board for Vocational Education has aroused general interest as has the new one of "farm mechanic." Inquiries are received daily from progressive farmers who want to employ these men, and from disabled soldiers who want to take the course.

Tractor operation is only one of the lines of activity of the farm mechanic; this in itself is an occupation with a future. Tractor operators are needed and experience of the men with motor equipment in the army will prove of value in this work. The tractor coming generally to be used on the larger farms is extending rapidly to the moderate sized farms. The average farmer is not a mechanic. Many of them realize that a tractor is a profitable outfit to have if they had a trained tractor man to run it. The large farms may afford to keep a man for the purpose but the farmer with 200 to 500 acres feels that unless he can run his own tractor he had better depend on horses. He knows he can run them.

The demand for men who can get efficient work from the tractor would be greatly increased if such men could be used in a profitable way between tractor jobs. A good tractor operator should be a natural mechanic; one who is ingenious and resourceful. If such a man can couple with his tractor ability a knowledge and ability to repair and keep in order the farm machinery, he has greatly increased his field of usefulness and chance of employment throughout the year. He also makes it possible for a farmer to take advantage of farm machinery which otherwise he might feel that he could not profitably use.

To qualify for this work a man should be able to care for and operate a tractor and other gasoline engines, be familiar with the automobile, understand the binder, mower and other farm machinery, be able to use a forge and make common welds in iron and mild steel, sharpen a plow, do a fair job of wood work such as make a wagon box, hay rack or repair on buildings, mend harness and have a working knowledge of electricity so he can care for a low voltage electric light plant including the storage battery.

With special training, such as is available to the wounded soldier through the Federal Board for Vocational Education, a man who has some mechanical ability and who wants to get into rural work can be sure of continuous employment. Many farmers will furnish house, garden, pasture for cow and other prerequisites that will enable a man to have a home and really enjoy life.

WE THINK of wireless transmission as through the air because most past development has been in that direction. Prof. J. R. Rogers has, however, devised a system for underground and submarine wireless transmission that has been tested out during the war, impulses being received from Europe, and plants having been installed at Great Lakes, Ill., Belmar, N. Y., and New Orleans, La. Wires are buried about 6 ft. deep in damp ground, and pointing in the direction from which the message is to come. Success has also been obtained in water 25 to 50 ft. in depth.

Air Lifts

THOSE WHO use air lifts for pumping water or other liquids will find that by placing check valves on the suction end of the discharge pipes they can increase the amount of water raised.

The nature of these checks will depend on the conditions where the lifts are used. For large open wells or tanks horizontal swing checks can be used; but for driven wells, or where space is limited, a vertical check or foot valve must be used. Figure 1 shows how to place the foot valve, and Fig. 2 shows how to arrange the horizontal checks.

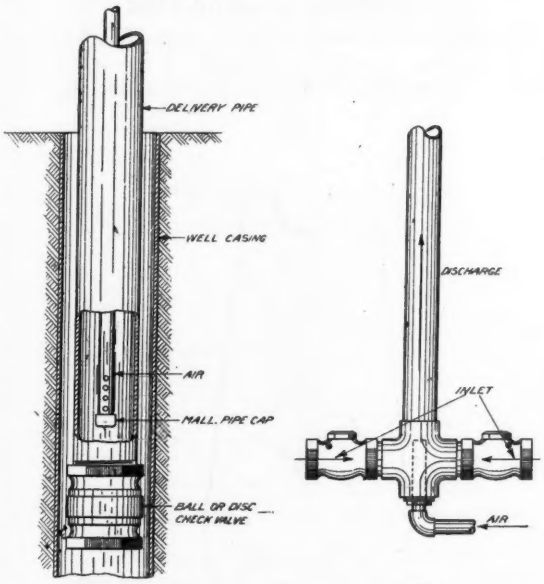


FIG. 1. METHOD OF PLACING THE FOOT VALVE
FIG. 2. ARRANGEMENT OF HORIZONTAL CHECKS

The use of an air lift will improve a driven well by removing fine sand and other small material which will not be moved by a deep well pump.

When using air lifts turn the air on slowly, as too much air will reduce the amount of material raised.

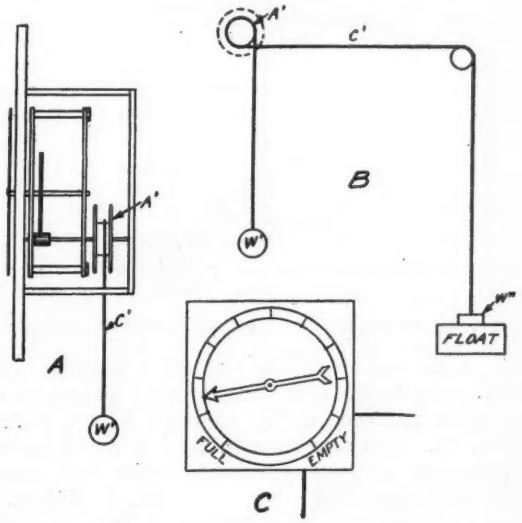
A. B. VIETH, JR.

A Handy Tank Gage

IN MANY installations there are water or oil tanks located in such positions that is hard to set the gage where it can be readily observed. A gage that can be placed in any convenient part of the plant can be made from the works of an old alarm clock and a few pieces of lumber.

Take the clock works apart and remove all the wheels, springs, etc. Select one of the larger gear wheels and a small pinion. Remove the shafts from these and make new ones from No. 14 wire or rod of about the same diameter. Referring to A in the accompanying illustration, you will see how the gear and pinion should be fitted to the shafts.

Drill out bearings in the frame and fit the shafts, taking care to see that the gear and pinion mesh properly and run freely. Drill a hole in the center of a board about 12 in. square, large enough to take the shaft of the gear wheel. Mount the frame on the board with the gear shaft in the hole. It should project about ¼ in. on the opposite side of the board.



DETAILS OF TANK GAGE AND ITS METHOD OF APPLICATION

Make a pulley of wood or metal and fit it securely on the pinion shaft, as shown at A'. The shaft should extend far enough beyond the pulley to enter a hole in the back of the wooden frame, forming an outboard bearing.

The hand may be made of thin sheet metal and soldered on the end of the gear shaft, but this should be done after the dial is in place, unless you prefer to lay out the dial directly on the board.

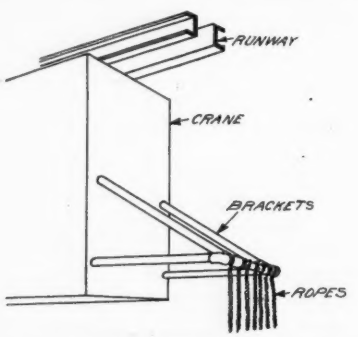
Mount the gage in any convenient place, high enough above the floor so that the weight W' will have a travel equal to the maximum rise of the liquid in the tank. Cord C' from the gage to the float may turn a number of corners, providing the corner pulleys run free. Place a weight, W", on the float, a little heavier than the one on the opposite end of the cord, to act as a counterbalance.

Direction of rotation of the hand may be reversed by changing the cord on the pulley A', so that the pull from the float comes on the opposite side of the pulley. To avoid binding, do not wrap the cord around pulley A' more than once.

The dial may be marked to indicate the rise and fall in inches and feet or in gallons and barrels, as desired. J. W. ESHNAUR.

Safety Device for Low Boiler Room Cranes

IN MANY boiler rooms traveling cranes of various kinds are used for moving coal and ashes, and in many cases headroom is limited to such an extent that the crane box for housing the operator extends down close to the floor. In one large boiler plant this crane cage extended down to about 6 ft. above the floor level and was therefore in a position to strike somebody working below if caught unawares. The crane was fitted with the ordinary bell, but in addition the boiler room men rigged up a further device for warning, as shown in the accompanying sketch. On each side of the cage they built up a light extension frame, and on this frame they hung a number of light ropes, which would strike a



METHOD OF APPLYING WARNING DEVICE TO CRANE

person in the path of the car and give a warning of the danger, much on the same order as the ropes which are hung along railroads at the approach to low bridges, tunnels, etc. This arrangement could doubtless be used to advantage in other situations where low moving bodies are encountered. M. A. SALLER.

Novel Means of Shifting Generator Load

WHEN I assumed charge of the plant in which I am at present employed, I found as part of the equipment two simple steam engines driving paper machines through the medium of large cone-pulley variable speed drives. The exhaust from these engines, which was considerably in excess of that required for drying and heating purposes, was delivered into a low-pressure main.

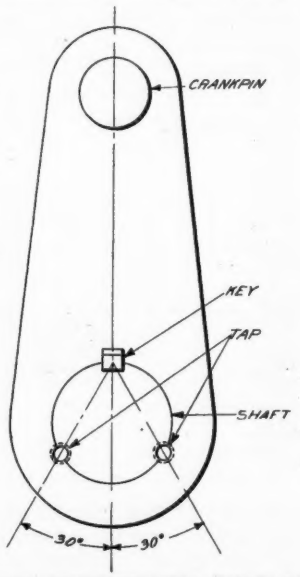
Because of their high rate of steam consumption, it was planned to replace these engines with new ones; but after giving the matter careful consideration, I caused this to be held up and recommended another scheme which proved entirely satisfactory.

The machine engines and their cone drives were discarded and in their stead motors installed, the current for the operation of which was secured from a steam turbine driven generator and belted generator operating in parallel. As the turbine was run noncondensing, exhausting into the low-pressure main, and the belted machine so arranged that it might be driven by means of a water turbine, a condensing engine or a noncondensing engine also exhausting into the low-pressure main, it was quite possible so to divide the load as to produce the desired amount of exhaust steam, especially with the belted machine driven by the water turbine or the condensing engine. In order to accomplish this automatically, a rheostat fitted with a sprocket wheel was connected in series with the turbine field rheostat and through the medium of a bicycle chain was connected to a damper regulator. The diaphragm of this regulator was subjected to the pressure of the steam within the low-pressure main and as this would increase, due to a decreasing demand, the regulator would operate the rheostat in such a manner as to introduce more resistance in the field circuit and in that way shift more of the load onto the other unit.

This arrangement, while not absolutely automatic, served well when there was an abnormal change in the demand for steam. F. E. SHELDON.

Tightening a Crank Disk

I NOTICED in the issue of Feb. 1, page 172, a suggestion to tighten a crank to a shaft. I am inclined to consider it a rather difficult task to get a steel shim be-



METHOD OF TIGHTENING CRANK DISK

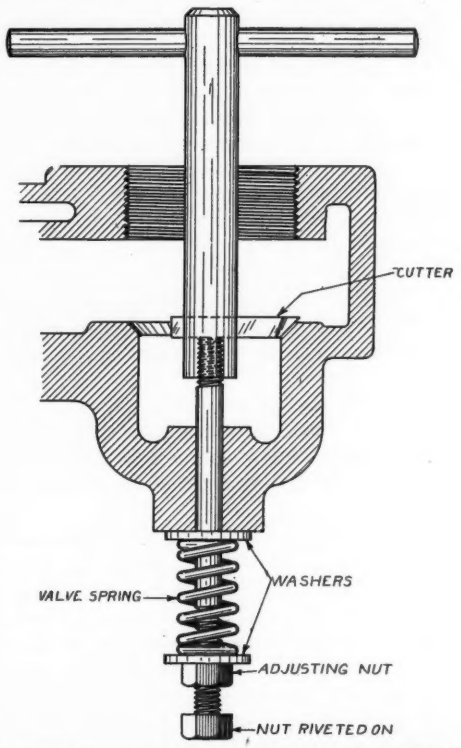
tween shaft and crank. I have had my troubles with a 28 by 60 and a 24 by 48 engine, and succeeded in getting both of these cranks tight, and never had any trouble afterwards. The accompanying sketch will show how it was done.

I had a machinist drill two holes halfway in the shaft and the crank for 1⅛-in. bolts; the drilling of these holes is not an easy task, I admit, but by setting the drill so it works more towards the steel shaft it will go all right. These holes were drilled about as deep as the crank is thick and tapped, finally, with a bottom tap and the bolts screwed in, but they have to go in very tight; to my recollection, we use a 36-in. wrench; cut the bolts

off flush with the crank and the trouble will be over; it is understood, though, that the key must be properly fitted in. H. B.

Valve Reseating Tool

THIS IS perhaps a unique idea in valve reseating tools, in that it uses the valve spring to do the work of feeding the cutter. The device is home-made. The upper half is a piece of round stock fitted with a handle and having a square hole drilled and filed in the lower end to take a piece of square file that has been ground to cut the beveled seat. The lower rod, which is of the same diameter as the valve stem, is threaded to screw



CONSTRUCTION AND APPLICATION OF VALVE RESEATING TOOL

into the bottom of the top piece. This secures the cutter at the position desired. The other end of this rod is threaded and a nut is run on, then another nut is secured on its end. This permits the regulating of the spring pressure for light or heavy chips, also to release the spring while setting the tool. C. H. WILLEY.

An Emergency Pipe-Thawing Outfit

SHOWN in the accompanying illustration is an emergency pipe-thawing outfit readily constructed and suitable for the thawing of frozen home-service pipes. When thawing 150 ft. of 2-in. pipe buried 4 ft. in the ground, about 33 kw. were required for a period of 20 min.

Essentially the equipment consists of two 10-kw. transformers with primaries connected in series across 2300-v. service lines and secondaries in parallel to give 55 v. No. 1 B. & S. wire is used, with one lead connected to a fire hydrant and the other through the medium of a water rheostat to any home faucet.

When a long pipe is being thawed, the rheostat plates may be allowed to come together without danger of burning out the transformer.

For the use of this outfit we have been charging our

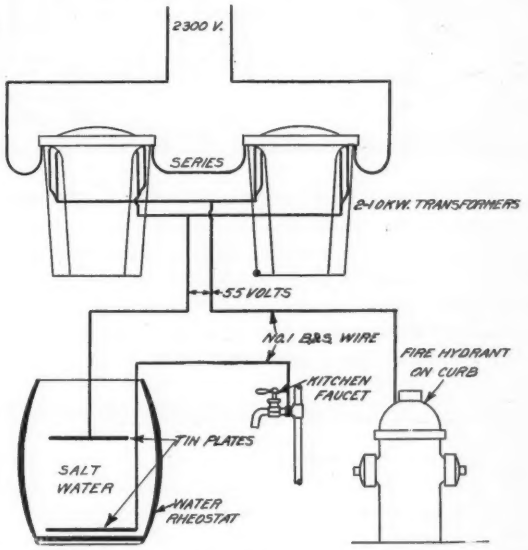


DIAGRAM OF CONNECTIONS OF EMERGENCY PIPE-THAWING OUTFIT

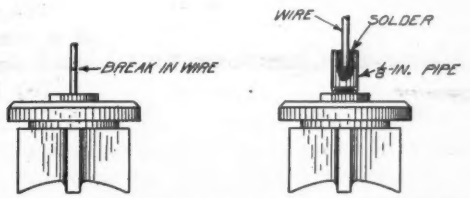
local water company $10 per hour, which included the service of one lineman and the current required.

C. A. S.

Repairing a Can Filler Valve Stem

WHILE REMOVING the foot valve of a can filled to replace a rubber seat, the stem, a length of brass wire 3/32 in. in diameter, broke off close to the valve. The can filler had to be in use the next day, and as no new wire was obtainable, I proceeded to make repairs in the following manner:

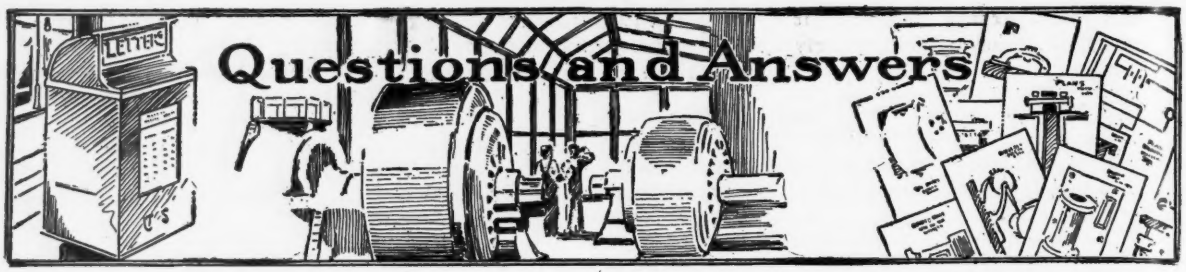
After having drilled and tapped a hole in the top of the valve to take 8⅛-in. pipe, I sweated a piece about



POINT AT WHICH WIRE WAS BROKEN AND METHOD OF REPAIR

1½ in. long into it. I then filled this short piece of pipe with solder, and while this solder was still in a molten state, I placed the wire (with its end slightly bent) into it, so that, upon solidifying, the solder held it securely in place and in such manner as to provide the necessary length. LEROY R. WILLIAMSON.

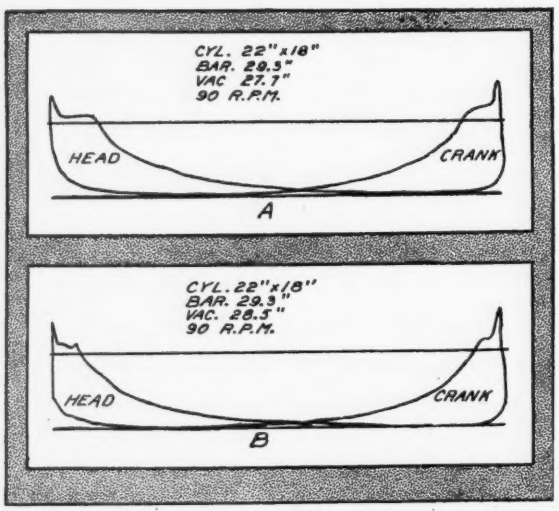
"NOTHING is so local as not to be of some general benefit."—(Lincoln.) Thrift and War Savings Stamps not only bring individual or community prosperity; they bring national prosperity.



Dry Vacuum Pump Cards for Criticism

SHOWN HEREWITH are two cards taken from a 22 by 18-in. dry air vacuum pump operating at a speed of 90 r.p.m. and used in connection with a barometric condenser. One of these cards was taken under a vacuum of 27.7 in. and the other under 29.3 in.

I am submitting these cards for criticism by the



CARDS TAKEN FROM 22 BY 18-IN. DRY VACUUM PUMP

readers of Power Plant Engineering. Is there anything wrong with them? If so, how may the defect or defects be remedied? C. E. N.

Electrical Machine Operation Questions for Answer

I WOULD greatly appreciate hearing from some of the readers of Power Plant Engineering as to what they might do under conditions such as mentioned in the following cases:

(a) A motor-driven exciter set employed in connection with an alternator operating in parallel with others burns off a lug on the motor, thereby killing the exciting current. The operator is at some distance from the board. He trips out alternator, places steam exciter in operation and starts over again.

He was called for tripping alternator because of the time lost by doing so. Was he right or wrong?

(b) Lightning burns out two current transformers, putting the line out of service. The operator cuts out one with a jumper and short-circuits secondary of the other; he then starts up, taking a chance on the second transformer being O. K.

Should he have cut out the second transformer to be certain against a second shut-down?

(c) A 600-v. d.c.—360-v. a.c., 300-kw. 500 r.p.m, 6-pole rotary converter employing half voltage reactance tap is thrown directly on full voltage. The field break of switch being open, a flash jumps from one blade of this switch to a screw head used to screw the base of this switch to the frame of the machine. The slate base cracks. The voltmeter was indicating positive polarity and the distance from switch blade to screw head was 1⅛ in.

What was the cause of this flash-over and about what voltage would do this and still not break down the insulation of the field coils?

(d) One of the collector rings on a turbo alternator developed several burned spots which continually became worse; carbon brushes in a box-type holder were used.

Plans were made to true up the rings; but before a turning rig could be secured, the brushes wore down against the stop, and when the low spots came around, they hung there, and as a result arced and burned the ring.

Arrangements were then made to shut down at midnight in order to smooth up the ring; but about 11 o'clock, with a flash issuing from the brushes, the whole load dropped. The engineer made the claim the flash occurred from ring to ring, a distance of 2½ in., while I am of the opinion that this peculiar behavior was due to the fact the brushes were unable to maintain contact with the ring, and as a consequence the circuit was broken and the excitation lost.

The ring was then smoothed up sufficiently by means of a sandstone block to allow operation of the machine until permanent repairs might be made.

(e) I should like to hear from somebody who has some of the new 60-cycle commutating pole rotaries on a trolley load as to flashing behavior during storms, etc. H. A. C.

Why the Peculiar Pump Performance?

I HAVE two No. 5 pumps in my charge which, up to a few months ago, ran well and did remarkable work under extreme conditions. We have about 26 ft. of lift and about 200 ft. head. The pumps did well for about 5 yr., with occasional spells, but of late they have become chronic invalids. They will take spells of stopping on one end and then will remain on that end, making very short rapid strokes. The stroke will be about ½ to 1 in. long.

If we cut off the water and allow the pump to run light, it seems to work perfectly; but as soon as it picks up the water, it will stop and begin short strok-

ing. We have ground the valves and have installed new valve cages, also a complete new steam chest and piston valve, with no benefit. We have also tried enlarging the small hole in the piston valve, thinking that the additional steam would throw the valve; but there was no change.

All gaskets have been examined and made perfect. In fact, everything about the pump seems to be in excellent shape, but the fact remains that there is something wrong.

Some of the readers of this magazine surely have had this same experience and have overcome it, and they are the ones I would like to hear from. Like all machines, this pump doubtless has some peculiarity which renders it liable to this one certain trouble. This is the only trouble the machines have ever given us, this unaccountable stopping on the end and a sort of indecision whether to go one way or the other. Anything that anybody has to offer will be appreciated.

C. C. H.

Preventing Undue Valve Rod Wear

As I am having considerable trouble with excessive wear of a valve rod on a Skinner engine, which I do not seem to be able to remedy, I am appealing to the readers of Power Plant Engineering for advice.

The rod wears mostly on the inner edge of the stuffing box toward the cylinder; already this wear is in excess of 1-16 in. M. N.

Governor Settings on a Double Eccentric Engine

In reply to the inquiry of T. J. B. appearing on page 258 of the March 1 issue, I would state that in setting any Corliss valve gear, the eccentrics are turned around the shaft and the length of the eccentric rods adjusted to make the rocker arms travel equal distances each side of the center line of their supports.

The usual form of construction provides an adjustment in the hook rod so that the length of that rod can be made to bring the wristplate, or rocker, into its center of travel when the rocker arm is plumb. When no adjustment is provided it is better to so adjust the length of the eccentric rod that the proper travel is imparted to the wristplate. With wristplate or rockers in the center of travel and the steam valve gear hooked up the radial rods from wristplate to the bell cranks are made of the proper length to give the steam valves the desired steam lap or as in the usual case of most double eccentric gears, negative lap. Move the steam valve gear into its extreme position each way and adjust the drop rod to such a length that no parts strike on the travel of the gear and yet the steam hook travels beyond the block enough to be sure of engagement.

Now turn the exhaust eccentric around the shaft until its wristplate or rocker is in mid position when the rods to the cranks are made the right length to give the desired lap or are line and line.

In regard to the position in which the governor is to be blocked when adjusting the knockoff rods, it is to be remembered that in valve setting the governor is to be put in what is considered its normal position for the average load, which is usually halfway between the extreme top and bottom positions. With the governor in this position and the rods set to release the steam valves at 0.25 stroke, the only way in which release can occur at any other point is due to a change in load or steam pressure which has a direct effect upon the speed of the engine and thus causes the governor to take up another position and cause cutoff to change. Therefore if we so locate the governor in its vertical plane as to represent its average position and make the rods of such length as to make equal cutoff at this point, the best results will be had.

With the governor blocked halfway up, turn the engine over in the direction it is to run and so adjust the length of the knockoff rod that the steam valve at the end of the cylinder the piston is leaving is just released when the crosshead has traveled 0.25 of the length of the stroke. Continue to turn engine in same direction until piston is on center and while turning slowly knock off the other knockoff rod to release the steam valve when 0.25 stroke is reached.

Raise governor to highest position and set safety cam so steam valves are not hooked up, then drop to lowest position and repeat the operation. If the governor spindle is provided with a collar to limit the upward travel of the governor, hold up the governor so no part can rise out of the guide slot and secure the collar.

From the foregoing it is seen that if the average load is such as to require a 0.75 cutoff, the governor is to be blocked in practically the same position as when the average load is carried with a 0.25 cutoff.

Receiver.

Why the Leaky Tubes?

A subscriber, whose communication appears on page 258 of the March 1 issue, desires to learn the cause and a proper remedy for leaky tubes in 7 by 20-ft. return tubular boilers used in a sawmill. Boilers in such work are generally subjected to quite severe service, and without knowledge of the actual conditions of installation and operation it is quite difficult to advance any suggestions.

It is, however, possible that the trouble he is experiencing with his boilers may be due to excessively heavy and unnatural strains such as might be caused by a settling of one end of the setting or unequal suspension or support. I would advise carefully going over these boilers to determine whether they are in proper alinement and to see if all points of support are carrying their share of the load.

Some time ago I experienced similar trouble, and upon careful examination, found that the boiler was 2 in. low at the front end, and that it was hanging by the rear left bracket and the front right bracket, thus subjecting all parts of it to tremendous strain.

After correcting this condition, I had no further trouble with leaky tubes. R. P. Everence.

I have seen numerous boilers which were considered practically free from scale, yet contained such heavy deposits on the rear end of the tubes and the back head that considerable leakage resulted. This was, as a rule, cured only by the removal of such scale and the re-expansion of the tubes.

Leakage may, however, also be caused by cold air

entering the fire doors and by the introduction of the cold feed water against or near the tubes.

The horsepower of the boilers referred to may be determined in the following manner: Where a tube has an external diameter, its internal diameter may be taken as 3.73 in., thus giving an internal circumference of 3.1416 times 3.73, or 11.718 in.; or an internal area equal to 11.718 times 20 times 12, or 2812.32 sq. in. Dividing this by 144, we obtain as a quotient 19.53 sq. ft., or for the 105 tubes a total of 2050.65 sq. ft.

The circumference of the shell is equal to 3.1416 times the diameter, 7 ft., or 21.99 ft., and as the length is 20 ft., the external surface is equal to 20 times 21.99, or 439.8 sq. ft. Considering one-half of this fire swept, we have a shell heating surface of 219.9 sq. ft. Adding to this the surface of the tubes, or 2050.65 sq. ft., we have a total of 2270.55 sq. ft.

Allowing 10 sq. ft. of heating surface per horsepower, we would have 2270.55 divided by 10, or 227 hp. as the rating of the boiler.

RECEIVER

[In calculating the heating surface of a return tubular boiler, it is usual to take ⅔ of the diameter of the shell rather than ½, and including in the total ⅔ of the area of both tube sheets less the continued area of

(A) METHOD OF APPLYING TUBE REPAIRER
(B) END REPAIRER IN PLACE

all the tubes. Making these corrections, the total heating surface became 2404.43 sq. ft., which would provide a horsepower rating of about 240.

EDITOR.]

THIS MAY BE DUE to two causes, improper rolling of tubes or cold and improper admission of feed water.

In the former case, where tubes have been removed and new ones rolled in, it is sometimes necessary to insert a shim between the tube plate and the tube to insure a fit. It might be well to look into this; but in my opinion, the feed water might be the cause of trouble if not properly admitted to the boiler. A Subscriber does not state at what temperature his feed water enters his boilers nor in what manner. But take, for instance, feed water which has not been subjected to any preheating whatever; when this water is fed directly into the hottest and most agitated part of the boiler, namely, the front section of the shell over the fire, the metal of the boiler suffers a terrific strain. Constant expansions and contractions of the tube sheet and tubes, resulting in leaks around tubes and girth seams, are the penalty for this style of feeding.

A remedy for this is to lead the feed water into the boiler at a point just above the tubes and along the length of the boiler nearly to the back head. Then let it cross to the other side of the boiler and discharge downward between the tubes and the shell. By this method, the feed water becomes heated almost to the temperature of the water in the boiler before it is discharged, thus avoiding the dangerous effects of continuous and alternate expansion and contraction of the boiler metal.

In computing the horsepower of the boilers referred to let us just consider the shell proper. Assuming half of the surface as heating surface we have the product of 3.1416, 7 and 20 divided by 2, and as a quotient obtain 219.912 sq. ft.

Each tube has an internal diameter of 3.732 in., so that by multiplying this by 3.1416 and dividing the product thus obtained by 12, we secure an internal circumference of 0.977 ft., which, times 12 times 105, will give us 2051.70 sq. ft. as the heating surface in the 105 tubes.

For accurate work, the heating surfaces of front and rear heads is considered. Squaring the diameter, 7 ft., and multiplying by 0.7854 we have 38.484 sq. ft. the area of the rear head. Two-thirds of this is 25.656 sq. ft.

The total cross-sectional area of all the tubes may be determined by multiplying the square of the diameter in inches of one tube or 4 by 0.7854 and 105 and dividing the product by 144. This is equal to 9.163 sq. ft.

Subtracting this from 25.656 we have 16.493 sq. ft. as the net area.

The heating surface of the front head is computed in the same way, with the exception that the total area of this head is used instead of ⅔ of it. In reality the front head surface above the water line is superheating surface, but this item is negligible. In figuring the horsepower of these boilers I have not taken the front head into consideration.

The total heating surface of each unit is therefore made up of the following:

Heating surface of shell	219.912 sq. ft.
Heating surface of tubes	2051.70 sq. ft.
Heating surface of rear hd.	16.493 sq. ft.
Total	2288.105 sq. ft.

For this type of boiler I allow 12 sq. ft. of heating surface for each horsepower; this is conservative. Therefore, dividing 2288.105 by 12 we obtain a boiler rating of 190.675+hp.

As there are three units the horsepower rating of the plant would be 3 times 190.675, or 572.02 hp.

J. W. S.

IN ANSWERING A Subscriber, I will say that we formerly had the same trouble with a 66-in. by 18-ft. return tubular boiler, the tubes of which would leak at the rear tube sheet. It was next to impossible to keep them tight, and after careful examination of the rear sheet, I came to the conclusion that the sheet had become crystallized to such an extent that it did not expand and contract with the tubes, for the tubes generally started leaking after a hard run when allowing the fires to cool down. The tubes would, of course, contract and it seems to me that the sheet did not contract with them and leakage followed, both the sheet and tubes being free from scale at the time. We therefore put tube repairers in each tube and haven't been bothered with leaky tubes since.

These repairers, which are patented devices and made either for use within the tube or at the end where it enters the sheet, consist each of two trough-shaped members provided with co-operating longitudinally inclined edges, thus securing a close fit when driving the two members into place within the tube.

As shown in the accompanying sketch, which illustrates the manner in which these repairers are put into place a special driving tool is required for this work.

By the use of the repairer indicated at B, I am certain A Subscriber could overcome much of his trouble.

WM. H. MORGAN.

IT IS, of course, difficult for anybody at a distance to tell why Subscriber's boiler tubes leak; and as he has explained that retubing does not help matters, I will suggest a remedy that will certainly prevent them from leaking in the future.

The best and only certain remedy is to have the tube ends electric welded. This is being done in New England quite extensively and no trouble has been had with them after welding. The process is not expensive and will hold them as long as the tubes last.

We have had several boilers of the Manning type develop a crack under the fire doors, sometimes 18 in. long. We welded those cracks and that settled that difficulty forever. We also have numerous fire cracks in the vertical seams and around the fire door. We apply the same remedy with these. We also put in a patch about 15 in. square, set the patch in place, level the edges and electric weld it into place. These repairs were made several years ago and no leaks in those places have troubled us since. The boiler inspectors approve of this method of making repairs and, in fact, recommend it. The expense for 2½-in. tubes is usually about $1 per tube. Of course, the larger tubes would cost more; but that expense is very small compared with the expense of retubing.

S. J. S.

Parallel Operation of Alternators

ON PAGE 171 of the Feb. 1 issue of Power Plant Engineering, and under subject "Proper Division of Alternator Load," it seems that you assume that varying the field excitation of alternating-current generators while running in parallel will shift or equalize the loads carried on the respective generators.

It has been my experience during many years of plant operation that changing the field excitation affects only the power factor condition of the generator. A generator, by over excitation or under excitation, will either be operating with a leading or lagging power factor; but the load will not shift from one generator to another by simply lowering or raising the excitation.

The division of load between two or more alternators operating in parallel cannot be changed by altering the field excitation, as is the case with direct-current generators. Changes in the load taken by any alternator of a group can be effected only by admitting more or less steam to the driving engine or turbine. In order that the various alternators shall share the combined load properly, it is therefore necessary that the governors on the several prime movers give the same speed load characteristics.

The cross currents of which L. B. was complaining are probably due to the periodicity of the prime movers. The angular velocity of machines running in parallel must be uniform, and if there should be a slight slowing up or speeding up, causing an angular displacement between different machines, a cross current will flow. A worn pick-up block, allowing the valve catch to drop too quick, would cause this trouble. If two gas engines are operated in parallel, a bad ignition plug in one cylinder will give trouble. Where steam engines and turbines are run in parallel, it is frequently necessary to alter the governor on the reciprocating engine, making it of the same sensitiveness as that of the turbine governor.

F. A. DARST.

Kerosene for Boilers

I NOTICED in the Power Plant Engineering issue of Feb. 15, 1919, on page 208, an inquiry regarding the use of kerosene in boilers, signed A. B. V. In reply to this inquiry, I submit my experience with the use of kerosene in boilers.

A few years ago, in Little Falls, Minn., where I used Mississippi River water for boiler feed purposes, I used kerosene with very good success. In Superior, Wis., where I had charge of seven boilers, I used Lake Superior water for boiler feeding, and I used kerosene with very good success. In Milwaukee, Wis., where I used river water for boiler feeding, I have also used kerosene with desirable results. This is the way I administered the kerosene: After the boiler was thoroughly washed out and closed up with the exception of the top manhole, I started the water into the boiler; I had a pail of kerosene at the top of the boiler near the open manhole. As soon as the water began to rise up through the feed pipe in the boiler and the blowoff pipe was filled with water so that the water began to spread over the bottom of the boiler, I poured the kerosene in it, allowing it to rise on the surface of the water. In this way, a very thin coat of the kerosene was applied to the boiler plates and tubes and the scale formation would not adhere to the iron. I do not think there is any danger in this way of applying the oil to the boiler plates and I have carried pressure as high as 125 lb. with boilers working continuously 24 hr. a day for three weeks at a time between washings.

C. S. TOMPKINS.

Expansion of Pipe Lines

I HAVE a pipe line about 300 ft. long made up of ½-in. pipe and fitted with an expansion bend near the middle. If there was no such bend in the line, how much longer would it be when it contained steam or was let us say at a temperature of 300 deg. F. than when at a temperature of 40 deg. F.?

J. W. R.

A. With a temperature difference of (300 minus 40 deg. F. or) 260 deg. F., the increase in length for each 100 ft. would be, for cast iron, 1.90 in.; for wrought iron, 2.09 in.; for steel, 1.99 in.; and for brass and copper, 3.02 in.

If, therefore, your line is 300 ft. in length, it will expand 5.70 in. if of cast-iron; 6.27 in. if of wrought iron, 5.97 in. if of steel, and 9.06 in. if of brass or copper.

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Were They Lucky?

Successful men are frequently called "lucky." Belief in a goddess of luck makes us dull and lazy. There is little use in anything. The luck theory of life logically concludes in predestination—it warps or kills our ambition to study, to prepare, and to grow. It is wholly unsound.

Men are beginning to realize that good luck and bad luck are matters of rigid law. Success doesn't just happen, neither does failure; both are results of our application of the principles of this law. Some term it "the selection and survival of the fittest." Anyway, the luck theory is almost obsolete, along with that old superstitious farmer who used to "sow by the light of the moon and reap by the grace of God."

Every man possesses an available reserve of pent-up possibilities and potentialities. Success is largely a measure of his ability to liberate and utilize these reserves. Every young engineer's career is in his own hands, and the degree of his desire to grow, his courage, his handling of opportunities, and his work will fashion his luck.

An inside view of the careers of men who have achieved success in allied engineering lines will indicate the extent to which they command luck and control their destiny. It shows that bigger and better things are possible for us all. It stamps a radiant, quickening influence on our work. It freshens our vision, and strengthens our purpose. Such biographical views will be offered our readers because we believe they possess real practical value as descriptions of real achievement.

How Can Business Be Improved?

Why doesn't business go ahead? Stocks of goods are low. Most manufacturers have been doing government work so that their regular product has not been sufficient to meet demands. Money is to be had and rates of interest are not high. All conditions seem favorable; yet there is a drag about getting started.

Buyers are holding off, anticipating a considerable reduction in prices. Government agencies are advocating such a reduction, and stating that the manufacturer must expect to take the loss. But it is difficult for a manufacturer, who has been forced to high prices by government competition for raw materials and labor to see how he can reduce prices, especially as wages show no sign of decrease. Indeed government agencies and economist writers are insisting that manufacturers must expect a new high level for wages, and they are undoubtedly correct. Labor leaders insist that there is to be no reduction from the high war time level, and in some industries demands are being made for a still further increase.

Under these conditions, how is a price reduction to be accomplished? For most products, the labor item, including labor of executives, is 60 to 70 per cent of the cost. Goods manufactured for peace markets cannot command such profits as are expected on war material for the government. But just now, taxes are so high that overhead is greatly increased, which offsets to a considerable extent the possibility of a reduction in price by taking smaller profits. Also, even those firms

which have been making war material and also their regular product have seldom got more than a normal profit —often less—on their regular lines. The increased prices have been due to increase in labor and material costs.

On the war material, the government will accept part of the loss and charge it to war expenses. But business and the people must pay for this through high taxes, and that means higher cost of peace goods. The balance of the loss on war material must be borne by the manufacturers who are caught with goods in process of manufacture and material bought at high prices to fulfill government contracts. This will reduce their expected profits to little if anything more than peace profits, and in many cases will result in a net loss on their work on war goods.

Taking a loss on peace goods for an indefinite period by reducing prices so as to get business going will result in a condition likely to be dangerous to all business. The loss can only be taken care of by using up accumulated surplus. No dividends can be earned for stockholders. Payment of bonds and interest on bonds may have to be deferred; and after the surplus is used up, the business faces bankruptcy.

With present high costs of living (which by the way are showing some signs of getting less) it is not to be expected that workers will look favorably on reduction of wages. And living costs can only be reduced through reduction of prices for food, clothing and rent. The action of the government in sustaining the price for all 1919 wheat was not a helpful measure in this regard, nor does it seem warranted by any considerations of fairness, as abrogation of the guarantee on the spring wheat would have come before the spring planting, and nobody would have raised a crop under any misapprehension as to the price he was to get. To maintain the price of wheat arbitrarily, load the cost onto the country in the form of taxes, and then ask manufacturers to accept a loss on their products savors of class legislation and had no basis in logic.

This resumé of conditions does not, however, answer the question, How can business be improved? It serves only to give an idea of the problems to be faced. And it should be remembered that a wise solution of these problems is of as much importance to the man who works for salary or wages as to the employer. No business means no employment. Improved business means more employment.

One point needs to be clearly understood. High wages, of necessity, increase the cost of the product, whether it be flour, meat, clothing or ships. With a universal high wage level, the prices for commodities must therefore be high, to the extent that labor enters into the cost of production. Therefore a high wage level, of itself produces, to a certain extent, high cost of necessities.

Where prices are such that they yield more than a normal profit, evidently they should come down. And it is quite generally argued by economists that profits in future must be less than they were in the pre-war period, for many lines of manufacture. Just how much the new percentage of profit is to be, nobody has, so far, ventured to predict.

Government agencies are attempting a procedure by creating a board to study conditions, consult with leaders of industry, and endeavor to secure agreement as to readjustment of prices to a new level low enough to induce the placing of orders, and to insure against further reduction for a considerable period, so that buyers will be protected against a falling market. The first effort is to be directed toward basic commodities such as iron, steel, lumber, cement, brick, copper and textiles.

Effort is being made also to stimulate building through starting of public improvements and an "own your own home" campaign. Reports from several cities show a shortage of housing facilities and indicate that delay in starting building is due to uncertainty as to the future labor and material market. The work of the board should help in this respect. If no lowering of prices is to be expected, it is wise to go ahead and accept the new cost conditions. If an agreement on a lower price level is reached, this will give stability to counteract the fear of future reductions.

So far as factory products are concerned, it would seem that the Plant Council offers a means of getting started. This plan, in brief, provides for a council of representatives of the management and the workers which shall have control of conditions of working, hours, recreation, health and safety provisions, and shall consider questions of wages, taking into account living conditions, possible price of product, selling costs and profits. The details of selection of the representatives on the council may vary according to the conditions of each plant or industry; but the idea of having the employes, through their representatives, made familiar with the problems of management and the factors on which wages depend has possibilities of far-reaching benefit in bringing employes and employers into more harmonious relations and a better appreciation of each other's point of view.

Through such councils it would seem possible to come to an understanding of what can be done in the matter of price reduction on the product of any given plant, through ascertaining what wages should be paid to give employes reasonable living conditions and what profits must be had to insure a reasonable return on invested capital. Such a basis for prices will give assurance of permanence that will create confidence in buyers, will stabilize industry, and will create a bond of confidence between the management and employes which will react to the benefit of both as well as to the prosperity of the plant.

Co-operation between Capital and Labor has long been preached as desirable. The Plant Council seems to offer a practical plan for trying to bring it about as well as a means for finding a reasonable level of prices under our new conditions which will permit business to go ahead with confidence that markets are not to be upset by future wide fluctuations.

THE CHAIRMEN of 88 draft boards, after conferences with representatives of the Illinois Manufacturers' Association and the Association of Commerce, authorize the statement that there will be jobs waiting for the 175,000 soldiers and sailors who entered the service from Chicago when they return. Those who do not receive their former positions will be promoted to better ones, it is said. The men will be provided with transportation to Chicago after they are mustered out.

New Tube Scraping Device

IN THE average boiler plant equipped with forced draft underfeed stokers burning bituminous coal or with the traveling grate stoker burning small sizes of anthracite or coke breeze, it is usual to operate the boilers at considerably above their rated or nominal capacity.

High ratings are obtained by high air pressure under the grates, the effect of which is to lift small particles of incandescent coke and ash from the grates, which are carried through the boiler in the furnace gases. A certain proportion of this coke or ash adheres to the bottom and sides of the tubes in the bottom row immediately above the fire.

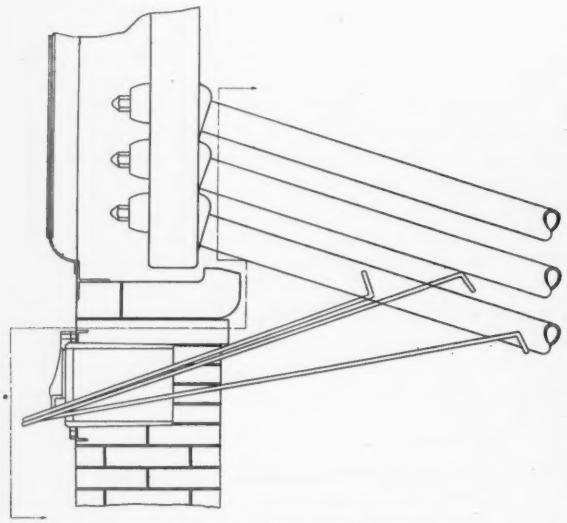

FIG. 1. TUBE SCRAPING DEVICE

A gradual building up of this cinder occurs slowly, closing the opening between the tubes, so that in the course of a few days or weeks, as the case may be, the area of gas passage is materially reduced, often so much as to reduce the capacity of the boiler.

This cinder cannot be dislodged by the usual soot blowers or tube blowers, nor by the older hand lance method, and the only recourse is to cut the boiler out of service and scrape the cinder from the tubes after cooling down the furnace. This is an expensive operation and would be entirely unnecessary if means were provided such that it would be possible to scrape this cinder off the tubes while the boiler is in service.

The usual tube dusting doors provided in horizontal water tube boiler settings do not give access to the under side of the bottom row of tubes. To meet this condition a tube scraping device is now available consisting of tube scraping door casting, bottom tube scraping doors, tube cleaning or scraping wall boxes, access doors for tube scraping, illustrated herewith, the purpose of which is to provide openings in the front or rear wall of a boiler setting through which a light hook may be used for scraping the cinder from the bottom and sides of the lowest row of boiler tubes.

These boxes are made in sections of three, four and five doors which are spaced the same distance apart as

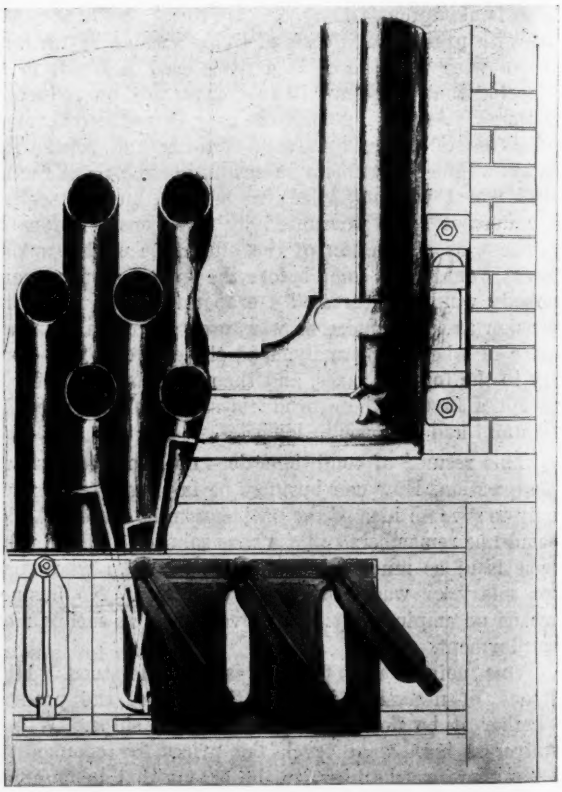

FIG. 2. VIEW SHOWING USE OF TUBE SCRAPING DEVICE

the boiler tubes in the boiler in which they are installed. Two or more sections are bolted on angles or Z bars along the top and bottom sides providing one opening or door for each space between tubes. The openings are not in line with the tubes, but are halfway between tubes so that the sides of the tubes may be reached as well as the bottom, and also the bottom of the second row of tubes.

The castings are of sufficient strength to support the brick wall above them and they will, when placed

under rear header of a horizontal water tube boiler, support the weight of the boiler also.

The boxes are about 12 in. deep and heavily ribbed vertically between each door or opening. When installed, the brick work is so laid that the boxes are protected from radiant heat and being in short sections of 21 to 35 in. in length will not warp and twist and loosen the brick work above and below.

Each opening is covered by a swinging door or cover, also of cast iron, the lower end of which passes behind a tapered spring catch which can be adjusted by a light blow of a hammer to hold the door tightly against the box.

When cleaning the tubes, the attendant takes a rod about ⅝ in. in diameter and 10 to 12 ft. long, of the same shape as an ordinary fire hook with one prong about 5 in. long. By striking a projecting lug on the door, the door is swung to one side and the hook pushed in the hole. The two tubes immediately in front of the openings are then scraped with one or two passes of the hook along the sides and bottoms and the hook withdrawn and the door closed by striking the door lug with the hook. In this manner, the lower tubes may be cleaned once a day or once in two days or more as may be required.

Every time a boiler is cut out and cooled down, it is necessary to burn a certain amount of coal merely to heat the boiler brickwork up to the normal operating temperature. This amount is variously estimated at from 600 to 1200 lb.

If the cinder is allowed to accumulate on lower tubes, the capacity may be reduced to the rated horsepower of boiler in two weeks' time and the economy will fall, particularly if the plant is designed for maximum economy at a certain overload. The sum of economies that may be maintained by the use of this device is considerable, and while it is difficult to give exact figures, it is not hard to show wherein the benefits derived will warrant the cost of the installation.

Making Temperature Trip the Circuit Breaker

THE oldest form of overload protection is electromagnetic, cutting off the current if it reaches a value deemed dangerous. The fact that most electrical apparatus can withstand momentary overloads without danger has gradually led operators to push up the current values at which electromagnetic protective devices will operate, or to dispense with them entirely, rather than undergo the inconvenience of having them disconnect the machinery on momentary peaks.

A method of visual protection on the basis of temperature was the next step. Exploring coils were built into the apparatus and used to indicate the temperature of hot spots by means of electrical instruments.

The latest step is a relay which automatically trips the circuit-breaker when the temperature reaches the danger point under excessive current. It may be used to protect any alternating-current apparatus from excessive heating if the apparatus is so arranged that exploring coils can be installed.

The relay is intended to protect apparatus against overheating from sustained overloads. To afford this protection with the least interruption of service, the breaker should be tripped through the direct effect of the temperature of the apparatus. The relay should be so arranged that it prevents the breaker from tripping if the overload is of such short duration that the temperature does not rise to a dangerous value; while, if the overload persists, the breaker must be tripped out as soon as the temperature rises beyond the critical value. This is accomplished in the relay as follows:

The relay operates on the Wheatstone bridge principle. Two arms of the bridge are copper exploring coils arranged to be placed in the oil or embedded in the windings of the apparatus to be protected; the other two arms are unchanging resistance mounted in the relay. The current for the bridge is supplied by the current transformer connected in the circuit of the apparatus to be protected. The relay has two windings, corresponding to and co-operating to produce torque in a manner similar to the current and voltage of a wattmeter. The main winding is a coil operating directly by the current transformer. The auxiliary coils are connected to the Wheatstone bridge arms similarly to a

RELAY USED TO TRIP BREAKER WHEN MAXIMUM TEMPERATURE IS REACHED

galvanometer connection, and thus receive current, the magnitude and direction of which depends upon the resistance of the search coils. Above a certain temperature, the torque of the relay is in the contact direction and below, in the opposite direction. It will thus be noted that in order to close the contact, two predetermined conditions must co-exist: excess current and excess temperature. Neither one will separately trip the relay.

The construction of the exploring coils will vary, depending on the kind of apparatus with which they are to be used.

OWING TO THE high price and scarcity of steel during the war, a gas company in Syracuse found it necessary to build the shells of a 200-hp. gas producer and scrubber out of concrete staves. The shells are 8 ft. in diameter and the staves measure 24 by 10 by 2½ in. They are connected by tongue and groove joints. Between the concrete and the fire brick lining there is a 3-in. space filled with a heat-resisting material.

News Notes

THIRTY first-class boilermakers are urgently needed at the United States Navy Yard at Norfolk, Va. Pay ranges from $5.36 to $6.40 for eight hours. Permanent employment is assured. Thirty days' leave with full pay is granted at the expiration of the first year of service, and for each month thereafter two and a half days' leave are allowed with full pay. When overtime is necessary, time and a half is allowed for all time in excess of eight hours. The Navy Department has authorized the Commission to furnish transportation to qualified men from point of departure to Norfolk, Va., if the men will agree to work for at least six months. United States citizens only will be considered. Full apprenticeship and good physical condition necessary. Application Form No. 1800 is required, which should be fully executed and filed with the Civil Service Commission at Washington, D. C. This form can be secured either from the Commission's office or from one of its field representatives. They are located in all of the larger cities of the United states.

THE TERRY STEAM TURBINE CO. makes the deferred announcement that since the death of Charles E. Hague in April, 1917, the company's interests in the Philadelphia district have been under the supervision of V. L. Sanderson, with headquarters at 605 Widener building. They further announce that James H. Weir has recently become associated with them as assistant to Mr. Sanderson in that district.

AT THE annual meeting of Engineering Council, held Feb. 20, Calvert Townley, Assistant to the President of the Westinghouse Electric & Mfg. Co., was reappointed Chairman of the Water Conservation Committee, also a member of the Reconstruction Committee for the year terminating at the annual meeting in February, 1920.

WILLIS B. CLEMMITT has joined the engineering staff of the Powdered Coal Engineering & Equipment Co., of Chicago, in the capacity of Advisory Engineer. Mr. Clemmitt was formerly Assistant Superintendent of the Open Hearth Department of the Central Iron & Steel Co., at Harrisburg, Pa.

CLINE B. FINNELL, who recently returned from the Officers' Training School at Camp Pike, Arkansas, and who is president of the Junior Chamber of Commerce of St. Louis, has been appointed secretary to Walter A. Zelnicker, president of the Zelnicker Supply Co., of St. Louis.

C. W. JOHNSON was recently appointed assistant manager of works of the Westinghouse Electric and Manufacturing Co. After graduating from Ohio State University, Mr. Johnson entered the employ of the Steel Motor Co., of Johnstown, Pa. A year later he became associated with the Bullock Electric Co., of Cincinnati, Ohio, and in 1904 was made superintendent of the Allis-Chalmers-Bullock, Ltd., of Montreal, Canada. In 1907 he entered the employ of the Westinghouse Co., being appointed Chief Inspector of works, later being promoted to General Superintendent, in which capacity he has served until his recent appointment. Mr. Johnson is a member of the American Society of Mechanical Engineers, American Institute of Mining Engineers and Engineers' Society of Western Pennsylvania.

GEORGE H. RUPPERT, who, before his entry into the Chemical Warfare Branch of the service had charge of a Sodium-Ferro Cyanide Department of the Semet-Solvay Co., has accepted a position as Advisory Engineer with the Powdered Coal Engineering and Equipment Co., of Chicago.

THE CHICAGO PNEUMATIC TOOL CO. has announced the appointment of J. I. Edwards as manager rock drill sales division, succeeding E. Eklund, who has been appointed special foreign representative and who will leave shortly for Europe in the interests of the company.

GIFFORD-WOOD CO., Hudson, N. Y., announces the death, on March 5, 1919, of its president, Malcolm Gifford.

THE UNITED STATES EMPLOYMENT SERVICE has further extended the scope of its work by the establishment of two new zone offices of the Professional and Special Section, in Philadelphia and Boston, and it plans to establish other offices of this Section in the near future. The new zone offices are in addition to the two main offices at New York and Chicago, and will serve the particular zones in which they are located.

By means of a comprehensive system, organized and directed by I. W. Litchfield, Chief of the Professional Section, every officer or man is being afforded an opportunity to state his education and experience in full. His qualifications, determined by a personal interview, are carefully analyzed and matched against the positions available in his particular line of work. As a result, employers throughout the United States who state their needs to the offices of the Professional Section, are daily receiving acceptable men possessing energy, initiative, education and practical experience in the especial work to be done.

New York office, 16 East 42nd Street; Chicago, 62 East Adams Street; Philadelphia, 1518 Walnut Street; Boston, 16 Tremont Street.

Trade Notes

M. & E. IMPROVED GREASE cups are made with a spiral spring inside, the top end bearing against corrugations on the top of the cup, thus preventing any turning from vibration. The cap is easily turned in either direction with slight force, but cannot lose off.

COLLECTOR RINGS that are rough and worn can be resurfaced and put in perfect condition without shutting down the equipment. An abrasive block is mounted on a suitable handle so that it can be held against the revolving collector ring or armature. The work is done, of course, while the equipment is running under regular load. Recent tests have been made on collector rings made of steel, copper and other materials and the results have shown that a new surface can easily be put on any ring—quickly, cheaply, without danger and without loss of time. Occasional use of this Ideal resurfacer will keep collector rings in perfect condition at all times.